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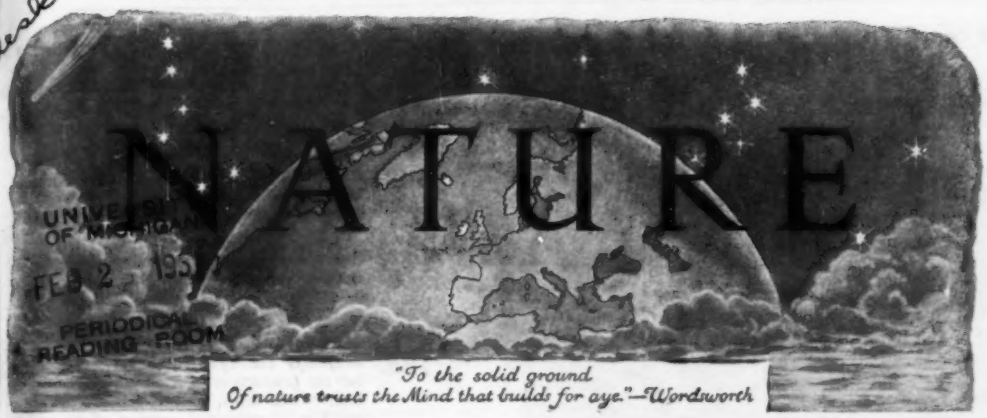

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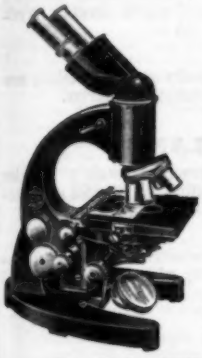

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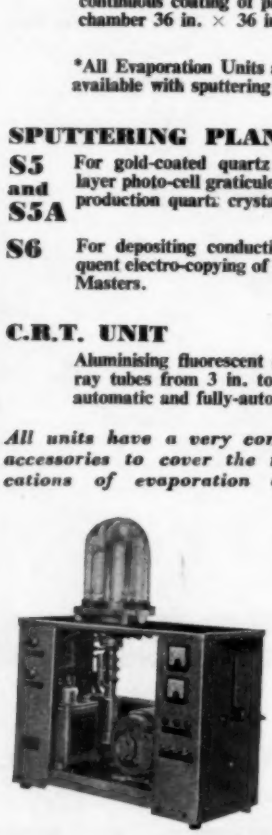

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THE CIVIL SERVICE IN THE MODERN STATE

SIXTY-SIX years ago, the American historian, Francis Parkman, closed his "Montcalm and Wolfe" with the following words regarding the United States: "She has tamed the savage continent, peopled the solitude, gathered wealth untold, waxed potent, imposing, redoubtable; and now it remains for her to prove, if she can, that the rule of the masses is consistent with the highest growth of the individual; that democracy can give the world a civilization as mature and pregnant, ideas as energetic and vitalising, and types of manhood as lofty and strong, as any of the systems it boasts to supplant". The Second World War alone abundantly established the capacity of democracy generally to bring forth manhood of the highest type; but two generations have scarcely enabled us to provide a confident answer to the first two of Parkman's implied questions. Nevertheless, his intuitive words are worth recalling at a time when there is increasing concern that, under democracy as well as in the totalitarian regimes, there are forces tending to repress rather than to promote the individuality and the imaginative and creative forces from which every advance in civilization has come.

Some consciousness of this is evident in the report of a survey of the state of education at the Massachusetts Institute of Technology and of a re-examination of the principles of education that have guided the academic policy of the Institute. The committee to which that task was entrusted has sought to determine whether those principles are applicable to the conditions of a new era emerging from social upheaval and the disasters of war. The report affirms that the premises of William Barton Rogers's philosophy of professional education are as valid as when he founded the Institute in 1861, and that its mission should be to develop men as individuals who will contribute creatively to society when strong forces oppose all deviations from set patterns. All education, it is urged, should prepare men for social responsibility; all education should concern itself with ends as well as means, with values as well as technique.

The committee considered its task to be to consider how the Institute might accomplish these purposes most effectively, with all that they imply in the encouragement of initiative, in promoting the spirit of free and objective inquiry and in recognizing and providing opportunities for unusual interests and aptitudes. So far as the content of technical education is concerned, these ideals are in line with what was said, particularly by Sir Ewart Smith, at a meeting of the London and Home Counties Regional Advisory Council of Higher Technological Education, held at Brighton on December 7. The meeting was concerned primarily with productivity and technical education in Great Britain; but the strong speaking there should assist materially in making technical education at all levels a consuming national interest.

On the wider plane, the issues at stake for the individual in the present tendencies towards centralization and increasing control by the State are well

discussed by Sir Harold Butler in two or three chapters of his recent book, "Confident Morning"*. Particularly in the chapter entitled "Servant of the Public", he brings his experience, first as a Civil servant in Great Britain, later as an international Civil servant when he was director of the International Labour Office, then as warden of Nuffield College, Oxford, and as a Commissioner for Civil Defence during the War, to bear on some of the problems of government in the modern State. His discerning comments are a valuable contribution to the debate on the development of modern government, particularly from the point of view of the Civil servant and of the ordinary citizen; thus he remarks: "The gift of teaching or the capacity for original thinking or research is much less common, and therefore much more precious, than administrative ability". That, it is true, was written of the excessive pre-occupation with administration which to-day often characterizes the senior members of a university; but the warning is equally valid where administration should be the main business, as at the centre of government, and not secondary, as in a university. It gains in force from the admiration which Sir Harold expresses for the achievements of Civil servants whom he has seen at work during two wars, when they have tackled vast new problems with initiative, imagination and energy. The Civil Service, he rightly points out, has twice passed the supreme test of war with immense credit.

Under the pressure of two wars, the Civil Service has shed many old habits; but it is well to be reminded that not all of them were bad. The increasing burden which now rests on the higher staff and often leaves them with little or no time for looking ahead is no small price to pay for the passing of the easy-going ways of the Edwardian era, and sometimes tends to offset the gains in organization and efficiency. Further, the fall in the standard of life of the higher Civil servant relative to other professions is not something to be regarded with indifference. Some facts disclosed in the recent report of the Civil Service Commissioners for the period January 1941 to March 1949 are disquieting. That in 1948 there were not enough candidates of suitable ability to fill the vacancies, although the standard was lower than in 1938 and the age limits were extended from 21–24 to 20½–33, may well be a reminder that a relatively underpaid Civil Service cannot attract enough of the best men, or keep them happy if they are attracted. Sir Harold Butler's international experience underlines this point, but equally pertinent to current discussion is his suggestion that the old relation between the Civil Service and the public has not remained intact. In the Edwardian era Sir Harold maintains that both Ministers and Civil servants were much less convinced that they knew what was best for everybody and much less determined to show them how they should order their lives. Ministers had not then tasted the heady wine of almost absolute power, and Civil servants regarded themselves as the servants of the public, not as their tutors or directors.

It is quite true that the expansion of the sphere of government and of the duties and responsibilities of the Civil Service have been largely inevitable, and the increase of the range of government activity has almost unavoidably led to some change in the outlook. The assumption has crept in that the public does not know what is good for it, and is therefore usually wrong, though it is but fair to note that, in opening a debate on the nationalized industries at the end of October last, the Lord President of the Council showed some appreciation of the older attitude and was concerned to restore it. What he failed to note on that occasion, however, was that the vast expansion of the sphere of government has in itself made good administration immensely more difficult, and that increasing remoteness of control has encouraged a growing section of the public to regard the Civil servant as their enemy.

The deterioration of old standards of social behaviour is, as Sir Harold reminds us, highly relevant to this discussion. It results in new pressures and difficulties for the heads of the Civil Service and their staff, and though there is no doubt of the integrity and devotion of the great majority, the general tone of the Civil Service cannot but be affected in time by the conditions prevailing in the public utilities and the great nationalized industries, the conduct of which in part now depends on them. The uneasy relations between the Government and the nationalized industries corroborates all that Sir Harold Butler writes regarding the value of criticism as a stimulant both to the morale and efficiency of the ordinary department of State and to the health of the nationalized industries.

The real question at issue is how that criticism can be most effectively made, having regard to the requirements of both efficiency and economic policy in these new national undertakings. Abraham Lincoln sometimes thought that it was impossible to give the State sufficient power to perform its necessary work without giving it so much that it becomes a danger to liberty. There are episodes which suggest a like reflexion concerning nationalized industry, and Sir Harold's analysis shows well where the danger lies. When he advocates the tonic of public criticism, however, he is fully alive to the danger of parliamentary question. The debate in the House of Commons on October 25, however, took us no nearer a solution of the problem of control in this field. Its failure to elucidate the real purpose of control—to ensure that the boards charged with making policy work on sound principles, with adequate knowledge—led to the inadequacy also being unrecognized of the Government's suggestion that each of the nationalized industries should be submitted, every seven years, to an inquiry of the type made periodically into the affairs of the B.B.C.

Such an inquiry may be a useful method of taking stock on the broad issues of policy and organization; but it calls for a different type of man than the measurement of efficiency, the investigation of which, moreover, must be regular. What is required, in fact, for the public corporations collectively is a watch-dog, such as is provided for Government

* Confident Mornings. By Sir Harold Butler. Pp. 192. (London: Faber and Faber, Ltd., 1950.) 12s. 6d. net.

departments by the Committee of Public Accounts. To the value of such a system Sir Harold testifies, though equally he recognizes its limitations.

Furthermore, it must be borne in mind, as *The Economist* has pointed out, that the new corporations, unlike the earlier public corporations, employ too many workers and are too closely in contact with the whole country to be kept out of politics. This has made it of the first importance that departments should not be closely concerned in detailed decisions of corporation policy. The dealings of the central government machine with each nationalized industry should be restricted to a few Civil servants competent to observe the broad directions of policy, and provide continuously an informed outsider's point of view representing, in some fashion, the national interest. Parliamentary debates and periodic inquiries might then play a useful additional part; but the clear delineation of responsibility is, as Mr. O. N. Chester has urged, a first condition, though the use made of the powers will still largely depend on men.

It is, in fact, on the individual that the survival of freedom and resistance to the present tendencies to centralization and to authoritarianism depend. We do not need to accept Niebuhr's theory of history to recognize that human institutions, civilizations and cultures do not merely grow, but that they can also decay and may need a re-birth if they are to have a fresh life. Bertrand Russell in his Reith Lectures referred to the possibility that the present tendencies to centralization may be too strong to be resisted until they have led to disaster, and that, as happened in the fifth century, the whole system may break down, with all the inevitable results of anarchy and poverty, before human beings can again acquire that degree of personal freedom without which life loses its savour.

Such warnings and reflexions are a stimulus to creative thought about the whole problem of government, at all levels from that of the local government area and the professional institution to the Cabinet level itself. The nationalized industries present only one aspect of the general problem, although they may well prove to include most of the particular features which present difficulty. But it would be a mistake to imagine that such creative thought by itself can solve our difficulties, or that the staffing of the Civil Service and the nationalized industries with men and women of the highest ability and integrity would provide a complete answer. They can only function effectively to the desired end when they are directed and guided by appropriate policies, and those policies depend in the end on the men and women whom the electorate returns to Parliament and thereby to Cabinet office. Not the least merit of the essay on Government which E. M. Young contributed to "The Character of England" is that it shows how the removal of the doubts concerning democracy expressed by Lincoln and by Parkman depends ultimately on the individual citizen, and Sir Harold Butler in his essay drives firmly home the same point in reminding us that for the preservation of a free society the State and its agents must remain the servants of the public.

THE PHILOSOPHY OF A PHYSICIST

Reflections of a Physicist

By P. W. Bridgman. Pp. xiii+392. (New York: Philosophical Library, Inc., 1950.) 5 dollars.

THIS collection of most of Prof. P. W. Bridgman's non-technical essays and addresses illustrates two main themes: the operational attitude towards natural science, and the liberal conception of the role of the individual in society. The author claims that the twenty-two chapters of the present book, written over a period of twenty years on subjects ranging from "Statistical Mechanics and the Second Law of Thermodynamics" to "The Strategy of the Social Sciences", possess a certain inner unity. This inner unity can perhaps be reduced to a single sentence chosen from his stimulating address on "New Vistas for Intelligence", namely, "Intelligence is based on the individual".

On this fundamental tenet the Nobel Laureate has constructed a philosophy of science and a philosophy of society. All the essays here presented were written after the publication of "The Logic of Modern Physics"; consequently the book opens with a reply to Lindsay's criticism of the operational method as originally presented in that classic of the philosophy of science. The peculiarly 'individual' character of this method, with its neo-Cartesian questioning of postulates and presuppositions, is apparent in the author's conception of meaning: "To know the meaning of a term used by me . . . I must know the conditions under which I would use the term, and conversely, to know the meaning of a term which my fellow uses, I must be able to reconstruct the conditions which compelled the use of the term by him". This theory of meaning is purely pragmatic, for in Bridgman's opinion no operation can be regarded as ultimately irreducible, and the precise operational use of a concept in dealing with experience must be expected to change as the range of experience changes.

One of the most penetrating criticisms which has been made of this theory is that we often find that two (or more) markedly different operations yield identical results; for example, the distance between two points can often be determined both tactually and optically, which suggests that perhaps the result is not purely operational. Prof. Bridgman acknowledges the difficulty but stresses the need to play safe and to distinguish explicitly between the different procedures, since the equivalence of the two operations is established only by experiment. The same emphasis on the individual and the particular appears in the chapter on "Science: Public or Private?", where it is argued that science is essentially 'private'. Bridgman defines science, perhaps somewhat clumsily, as "an activity which satisfies certain criteria of success in meeting the environment", the essential feature being that these criteria are applied by 'me'. Consequently, if science is further defined as 'public' it is then over-defined, whereas if it is first defined as 'public' then it would appear to be impossible for a Robinson Crusoe to indulge in scientific activity. I believe, however, that here Bridgman has wrongly stressed the role of the individual. The agreement between individuals which is the basis of 'public' science need not be actually realized in practice; the essential point is that it should be realizable in principle, for the possibility

of ultimate agreement is surely the hallmark of all scientific activity.

Nevertheless, the strong emphasis here laid on the individual provides a corrective to much contemporary thinking. In an inspiring address on "The Struggle for Intellectual Integrity" the commonly held belief that science is ethically neutral is implicitly controverted in a carefully argued claim that "the activity which *par excellence* demands and exemplifies intellectual honesty is the scientific". We are also given a timely reminder that the mainspring of scientific activity is the craving for understanding. Indeed, Bridgman would agree that its object, as Jacobi pointed out in a famous retort to Fourier, is "the honour of the human mind".

Despite an occasional jarring split infinitive, the style of most of these talks and addresses is admirable, and it is difficult to put the book down when once begun. This is a work of immediate importance and at the same time of permanent significance, of value both to the 'external' and the 'internal' study of science.

The printing is excellent, the binding ugly.

G. J. Whitrow

PREHISTORY IN NORTHERN RHODESIA

The Stone Age Cultures of Northern Rhodesia

With Particular Reference to the Cultural and Climatic Succession in the Upper Zambezi Valley and its Tributaries. By J. Desmond Clark; with a Chapter on the Geology, by Dr. F. Dixey, and Appendixes by H. B. S. Cooke, L. H. Wells and Geoffrey Bond. Pp. xii+157. (Claremont, Cape: South African Archæological Society, 1950.) 21*s*.

DR. DESMOND CLARK is the curator of the Rhodes-Livingstone Museum. He received his archæological training at Cambridge in the Faculty of Archæology and Anthropology, and has since had the opportunity of travelling widely in Africa during and since the Second World War. This present work is the major part of a thesis submitted for a Ph.D. degree, and its publication in book form has been undertaken by the South African Archæological Society. There is included a chapter on the geology by Dr. F. Dixey, and appendixes by H. B. S. Cooke, L. H. Wells and Geoffrey Bond on Quaternary fossils from Northern Rhodesia, on fossil man in the area, and on the dating of deposits of Kalahari sand, respectively. There are a number of plates, figures and diagrams illustrating the general features of the country, the industries found, and various sections and maps. The whole is a first-class piece of work, dealing with a crucial region from the point of view of the prehistory of South Africa, and indispensable for every student of early man in that part of the world.

Dr. Dixey opens with a general account of the geology of the Zambezi Valley. It is based not on the evidence of vague mapping, but on a detailed survey of the region. Interesting is the fact that the earliest (pebble) industries seem to appear in the region slightly later than they do in East Africa. This tends to confirm the idea—also applied to the rather later Stone Age cultures—that there were continual migrations into the sub-continent from elsewhere which had to pass over the barrier of the Zambezi, and that the size of the river and the difficulties of crossing it created a bottle-neck or -necks through which the migrating folk had to pass before they could fan out over the easier country of Southern Rhodesia and the Union.

Clark carries on in Part 2 with an account of the stratigraphy and cultural succession, followed by a description of the industries associated with the various cultures. A series of invaluable sections is given which relates the various finds of archæological material with the geological succession already determined. A climate sequence for the several cultures can thence be determined, and it is interesting to see how this agrees with similar climate sequences in other parts of Africa. The cultures found include, of course, an early pebble-tool making culture, the Chelleo-Acheulean culture, the Sangoan, Still Boy, Magosian, Wilton and Neolithic. In the Nachikufu Caves there are some paintings, of no great beauty, but interesting from the locality where they occur.

The volume concludes with the various appendixes. The whole is a sound and solid piece of work; doubtless there will be further details to add, but the foundations for the study of Northern Rhodesian prehistory have been well and truly laid.

M. C. Burkitt

ORGANIC CHEMISTRY FOR HONOURS STUDENTS

Perkin and Kipping's Organic Chemistry

By Prof. F. Stanley Kipping and F. Barry Kipping. New edition. Part 1. Pp. xi+370+xxxii. 7*s*. 6*d*. Part 2. Pp. xi+371–694+xxxii. 7*s*. 6*d*. Part 3. Pp. xii+695–1130+xxxiii–lviii. 12*s*. 6*d*. (Edinburgh and London: W. and R. Chambers, Ltd., 1949.)

THIS new edition of "Perkin and Kipping", written by the late Prof. F. S. Kipping and by Dr. F. B. Kipping, will be accorded by students the same welcome to-day as was the original "Perkin and Kipping" by their grandfathers. The handy three-volume pocket size and reasonable price will appeal to students. This edition has clearly been substantially rewritten and entirely reset. The number of pages has been increased, but this is due to the use of a larger and more pleasing type-face as well as to the incorporation of additional material. The reader is quickly struck by the clarity of the formulæ of cyclic compounds, particularly those of heterocyclic compounds, in which five- and six-membered ring systems are drawn as regular pentagons and hexagons respectively. The authors, artist and block-maker are to be congratulated on this welcome innovation.

Parts 1 and 2 constitute an introduction to organic chemistry. The subject is treated from a practical point of view, preparative details being interspersed in the text, and the preparations and reactions of individual compounds are elaborated before generalizations, in the form of chapter summaries, are made. Simple theoretical ideas, such as those of resonance, are integrated throughout the text instead of being relegated to a chapter at the end. Heterocyclic compounds are given more extensive treatment than is usual in a text-book of an introductory character. Following this throughout the text instead of being relegated to a chapter at the end. Heterocyclic compounds are given more extensive treatment than is usual in a text-book of an introductory character. Following this throughout, the subsequent use of Part 3 will go a good way to satisfying the requirements of honours students. The descriptive chapters

on natural and synthetic products are good and reasonably up to date; those on "Vitamins and Conjugated Proteins" and on "Steroids" are excellent.

It is clear that the authors are very sceptical of the developments in theoretical organic chemistry of the past twenty years. For this reason the text, particularly in Part 3, suffers from a lack of balance. Topics such as heterolytic and homolytic substitution are either omitted or only mentioned in a rather unsatisfactory manner. Free radicals of long life are dealt with as compounds of abnormal valency, in a chapter also devoted to steric hindrance. The use of semi-colons and full-stops at the end of equations (for example, p. 1041) makes it difficult for the reader to be sure if the formation of radicals is intended. In the discussion of the Walden inversion, no hint is given of the light that has been thrown on this problem from the elucidation of the mechanisms of aliphatic substitution reactions.

However, within the limitations mentioned above, this new edition of "Perkin and Kipping" should continue to serve students of organic chemistry as its predecessors have done during the past half-century.

S. H. HARPER

FIBRES

Fibre Science

Edited by J. M. Preston. Pp. xiv+341. (Manchester: Textile Institute, 1949.) 30*s*. net.

Physics and Chemistry of Cellulose Fibres, with particular Reference to Rayon

By P. H. Hermans. (Elsevier's Polymer Series, No. 2.) Pp. xxii+534. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1949.) 50*s*.

DURING the past quarter of a century, fibre structure has been the subject of much research in many parts of the world. As a result, a substantial measure of agreement has been reached as to the fundamental nature of the fibrous state and about the way in which this determines those properties of fibre-forming materials which have come to be recognized as essentially fibre-like. This broad foundation carries upon it superstructures relating to the individual fibres or groups of fibres, the most impressive being those for the cellulose and keratin groups, which are concerned with the more intimate details of structure and properties. No specialist, however, can afford to disregard work which is being done on fibres other than his own; and the general reader wishing to know something about fibres will be well advised to obtain, at the outset, a picture of the entire field of fibre study.

The Textile Institute has, in recent years, set itself the task of presenting such a picture, both in a popular and more advanced form, to as wide a circle as possible. "Fibre Science" is a series of articles of degree standard by thirteen contributors, based upon lectures given in 1947 in Manchester. These articles range over the whole field from the chemistry of the different fibre types and X-ray analysis to the physical and physico-chemical properties of the fibres. Covering such a wide ground, they must appear in places to deal rather superficially with certain topics, but this can be condoned in a work which, on the whole, gives a very good idea of the achievements of research in this very complicated field of inquiry. A few minor points of criticism may be noted. The appearance of the volume is not improved by the use of two kinds of paper. On p. 207 stress in kilometres weight is wrongly referred to as *breaking* load per unit linear density, and on the next page the reader is asked to envisage the process of "extension of the fully extended polypeptide chains". Finally, I have a personal dislike of the use of the two terms 'amorphous' and 'crystalline' as mutual exclusives, and even though some contributors do explain what they mean by the former and perhaps may use inverted commas round it, this can at best turn the dislike into reluctant tolerance.

The question of the influence of the non-crystalline parts of fibres on their properties has become one of the major subjects of active research. It is dealt with in two chapters of "Fibre Science", and in a sense is the underlying theme of P. H. Hermans's book, "Physics and Chemistry of Cellulose Fibres". Hermans is, indeed, one of the leading authorities on this subject, as far as cellulose fibres are concerned, and his "Contributions to the Physics of Cellulose Fibres" is well known to British workers. The subject-matter of that monograph (with minor modifications and the addition of a chapter on mechanical properties) forms the second of the three parts into which the present book is divided. The first part has chapters on crystal structure, solutions and gels, chain-length, degradation and the differences between native and regenerated cellulose, and it serves as a general physico-chemical introduction. In the third part Hermans discusses the very complex swelling, shrinkage and deformation behaviour of gels; this, as he rightly affirms, must be properly known and understood if the technology of regenerated fibres is to be anything more than a series of semi-empirical operations. The picture of a cellulose gel which he adopts is one of a continuous network of chain molecules with nodes (not necessarily restricted to the more crystalline patches) which on the whole remain stable during the deformation. Quantitatively, his theory is a modification of Kuhn's, and while Hermans admits that full agreement with experiment is not attained—and indeed this would be too much to expect—there is no doubt that considerable progress has been made in exploring this most difficult field.

As usual, Hermans's writing is very stimulating. He has an extraordinary knack of getting the most out of the simplest physical ideas, and it is perhaps on these grounds rather than because of the conclusions reached that the book will be most useful. Mention should be made of the immense scholarship shown by the compilation of well over a thousand references, many of them multiple; some readers may, however, find that here and there the text is rather overburdened with undiscussed statements that 'X said this, and Y observed that'. A few spelling mistakes have been noted, as well as a displaced line of print towards the bottom of p. 88, and on p. 269 (eight lines from foot of page) "fineness" is wrongly used for "strength".

"Physics and Chemistry of Cellulose Fibres" will undoubtedly be read by the majority of research workers on fibres. "Fibre Science" will have a wider appeal; and if it is to be reprinted (the Textile Institute has just announced the exhaustion of the first issue) it could, with some modifications (I have in mind a rather more specific treatment of the physical properties of the various fibres), be made into a very useful text-book for university students of textiles and other sciences, for example, botany.

H. J. WOODS

THE GREAT ASSAM EARTHQUAKE OF AUGUST 15, 1950

By ERNEST TILLOTSON

AN earthquake, which appears to have been the greatest since the time when seismological observations were first established, occurred at 14h. 09m. 30s. G.M.T. on August 15, 1950. The epicentre was near lat. 28·6° N., long. 96·5° E., which is just in Assam near the borders of India and Tibet. There is no reason for supposing, with the data at present to hand, that the depth of focus was other than normal, that is, some 14 km. below the earth's surface. The magnitude of the earthquake on the Richter instrumental scale, calculated independently using seismogram measurements at Pasadena (California) and at Strasbourg, was 8·6. There has only been one other earthquake with this magnitude since instrumental recording became general, namely, that of January 31, 1906, in Colombia. Its depth of focus was normal. Other shocks of normal depth with only slightly smaller magnitude occurred on August 17, 1906, in Chile (8·4); January 3, 1911, Tien Shan (8·4); December 16, 1920, Kansu (8·5); and March 2, 1933, Japan (8·4). The greatest shock of intermediate depth occurred on June 15, 1911, in the Ryukyu Islands (8·4), with a depth of focus of 160 km. The greatest deep-focus earthquake happened on January 21, 1906, in Japan (8·0) with a depth of focus of 340 km.

The epicentre given above was calculated by Dr. E. Peterschmitt and Prof. J. P. Rothé from data sent by eighty-six seismological observatories throughout the world to the International Seismological Bureau at Strasbourg. That the shock was single, that in general the primary wave began impulsively, and that the beginning was well recorded, untroubled by microseisms at the majority of the stations, is shown by the remarkably small observed–calculated values for the *P*-waves in all azimuths from the epicentre. Dr. A. E. M. Geddes, of the Department of Natural Philosophy, University of Aberdeen, has kindly supplied the seismograms reproduced herewith, and the tentative interpretation by Dr. Geddes and myself is as follows (arrival times in G.M.T.):

Record	Wave	hr.	min.	sec.
N.E.	*iP*	14	20	50
N.E.	*PcP*	14	21	08
N.E.	*PP*	14	23	33
N.	*i*	14	23	44
N.	(*PPP*)	14	24	42
N.E.	*i*	14	25	15
N.E.	*S*	14	30	09
N.E.	*PS*	14	30	45
N.E.	*ScS*	14	30	50
N.E.	*PPS*	14	30	59
N.E.	*i*	14	34	50
N.	(*SS*)	14	35	16
N.E.	*SSS*	14	38	07
N.E.	*L*	14	46	00
N.E.	*M*	14	50	
N.E.	*F*	20	12	

The period of the measured *M*-waves was 22 sec. and their amplitude greater than 3,170 μ. It will be seen that the trace is off the chart at maximum on one side. At the time of the shock, Mr. H. V. Shaw was standardizing Milne–Shaw seismographs at the London works of Messrs. Hilger and Watts for delivery to India and Pakistan, and he had to abandon the work while the waves from the earthquake were arriving in London.

Every earthquake appears to begin in a very small volume at its focus, and the various types of waves starting there spread outwards in all directions, each with its own velocity. Thus in the epicentral area a single earthquake will be of very short duration and intense, whereas at more distant stations the various types of waves will be more spread out on the seismogram, complicated by reflexions and refractions at various discontinuities and also by the different elastic properties of the rocks through which they pass. As the energy spreads out, the earthquake will also exhibit smaller intensity and the waves smaller amplitude. At Calcutta the waves took about one minute to pass. At Kew, Stuttgart and Pasadena (California), *P* began with a compression wave. At Kew, the maximum waves had a period of 22 sec. and an amplitude of 28 mm., while at Stuttgart the maximum waves had a period of 21 sec. and an amplitude of 10,000 μ. Aftershocks from the same epicentre have been frequent and violent. The first at Kew was recorded 17 min. 52 sec. after the original earthquake, that is, after the arrival of *SSS* (a transverse body-wave twice reflected at the earth's surface between focus and observatory) and before the long surface waves arrived. Twenty-two separate and distinct aftershocks were widely recorded between August 15 and 26. So late as September 2 an aftershock had a Richter instrumental magnitude of 5$\frac{1}{2}$, and strong aftershocks were recorded during November.

The macroseismic data are being collected slowly owing to the nature of the country in which the epicentre was situated and to the tremendous geological and topographical effects and the damage to communications. The earthquake was felt beyond Calcutta and Rangoon. Capt. F. Kingdon-Ward, with his wife, was camping in the epicentral area at the time of the earthquake, and his account of the earthquake follows this article. To have felt and heard

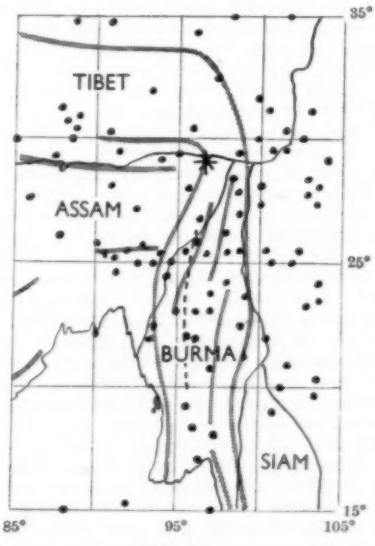

Fig. 1

•, Epicentre for August 15, 1950; ●—●—, previous epicentres: axes of mountain ranges, hatched lines; negative gravity anomalies, broken line

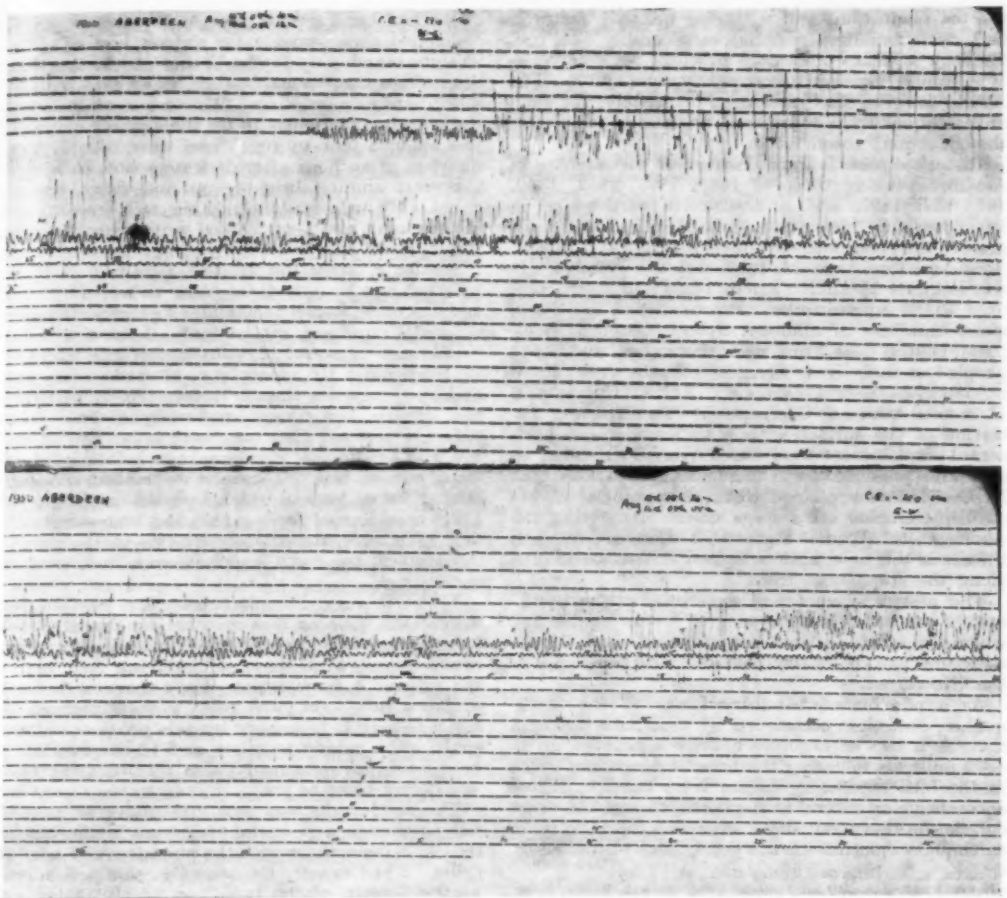

FIG. 2

Seismograms obtained at Aberdeen with Milne–Shaw seismographs showing earth-waves started by the great earthquake in Assam on August 15, 1950. Each trace begins at the top and runs from left to right, the small gaps being minute marks and the large gaps hour marks. Written on each seismogram is the time by the observatory clock of the start and finish of the trace, and the clock error from Greenwich Mean Time. The upper record shows N—S ground vibrations and the lower one E—W vibrations. In the N—S record the Primary or longitudinal waves arrive first (on the 7th complete line down) and occupy about 9 minutes, after which the Secondary or transverse waves arrive. The latter, on this seismogram, have greater amplitude and occupy some 16 minutes, after which the Long waves arrive, which on this seismogram have a greater amplitude still. During the maximum phase the trace goes off the paper at the top. The remainder of the record is the coda. The displacement of the trace due to the violence of the shaking, giving a wide gap, has made the record more legible since there is little overlap. Much the same remarks apply to the lower seismogram, though there has not been so much displacement

the original earthquake touching off one surface fault movement, which in its turn touched off another and another, each with its own local tremors like a train of terrific explosions, must have been a terrifying experience in such a place, and I, for one, am grateful to Capt. Kingdon-Ward for committing his experiences to paper. The Rev. Francis X. McFarland, *S.J.*, wrote from Darjeeling that the earthquake caused the lights in St. Joseph's College to swing through an arc of 20°. Although a heavy monsoon rain was falling at the time, people in panic filled the streets and refused to return to their houses.

Some 20,000 square miles of territory in Assam appear to have been seriously affected by the shaking and subsequent floods. No news has yet been received from Tibet or from Burma. The Assam Zone has an approximate width of 100 miles and follows the general line of the Brahmaputra River, north-east from Tezpur to the border of Eastern Tibet. In this area the shaking left very few buildings undamaged. Most of the countryside on each bank of the river sank, in some places between 5 and 6 ft. Roads were twisted, cut up, breached and lowered. Railways were similarly damaged and bridges destroyed. Agricultural soil was upturned and fields flooded, causing havoc in rice fields. It was too late to plant again that season. There were multitudes of dead fish. The dam on the main Brahmaputra River north of Pasighat broke and caused serious flooding. The Subansiri River was dammed where the river comes through a gorge with cliffs 1,000 ft. high; when this dam broke the sight must have been awe-inspiring. In the plains the most severe shock was felt in the districts of Lakhimpur and Sibsagar. There was heavy damage in the towns of Dibrugarh, Jorhat, Lakhimpur and Siliguri. Landslides affected some of

the tea plantations and withering houses; factories and other buildings suffered considerably. A preliminary estimate of damage by three tea companies is £184,000. Damage due to earthquake and flood in Assam may be £20 million. Fortunately, for such an earthquake the death-roll appears to be slight, though it may reach 1,500.

Historical records show destructive earthquakes in Assam, including those of 1663, 1845, 1852, 1869, 1875 and 1897, and a destructive earthquake in Bihar-Nepal in 1934. Capt. N. H. Heck believed that, prior to the present shock, the earthquake at 5.15 p.m. (local time) on June 12, 1897, was the greatest. It was felt over 1¾ million square miles and destructive over 30,000 square miles. Practically all brick and stone buildings in Shillong, Sylhet, Gauhati, Goalpara, Dhubri and Tura were destroyed, and 1,542 people lost their lives. Some 600 deaths were caused by landslips near Cherrapunji, 117 at Cheyla and 17 in coal mines at Cherrapunji[1]. Faulting and distortion of the surface with both vertical and horizontal displacement were found over so extended an area and presented such complicated relations that R. D. Oldham explained them as superficial effects of displacements on a large thrust underlying the Assam Hills. Wadia[2] states that there are no such thrusts in this area, although great thrusts are known along the Himalayan front.

The present epicentre is somewhat to the north-east of the major seismic zone of Assam and is just where the north-north-east–south-south-west Burma structural axes meet the east–west structural lines of the Himalayas.

As a possible contributory factor to the earthquakes, doubtless occasioned by mountain building, there is a belt of negative gravity anomalies up to −75 milligals following the lines of maximum uplift in the hills separating Assam from Burma. These anomalies may extend to the north, though the exact correlation between such anomalies and belts of earthquake epicentres is not yet definitely established.

[1] Oldham, R. D., *India Geol. Survey Mem.*, **29**, 1 (1899).
[2] Dunn, J. A., Auden, J. B., Ghosh, A. M. N., and Wadia, D. N., *India Geol. Survey Mem.*, **73**, 1 (1939).

NOTES ON THE ASSAM EARTHQUAKE

By Capt. F. KINGDON-WARD

On August 15, 1950, my wife and I were camped in the village of Rima, on the left bank of the Lohit River, approximately lat. 28° 30′ N., long. 97° 00′ E., at an altitude of 5,000 ft. Rima is not really the name of a village, but rather of a small district containing five or six villages of rude timber houses and granaries, with a total population of a few hundred people.

Between the Rong Thō Chu–Zayul Chu confluence, a mile north of Rima, and the McMahon Line to the south, the Lohit gorge suddenly opens out, causing a sort of amphitheatre, some three miles from north to south, mainly on the east bank, where the villages are situated. The river itself is here more than 600 yd. wide, twisting as though it were flowing across a flood plain. All around, the mountains rise very steeply from the flat terraces, a cluster of snow peaks on the Burma frontier, more than 19,000 ft. high, lying within the twenty-five mile radius; but only four miles from the river they are already 15,000 ft. high. Hence Western geographers might speak of the 'Rima basin'.

We had been several days in Rima, and had just concluded arrangements for sixteen porters to take us three marches up the La Ti torrent which, crashing down from the Burma frontier, flows into the Lohit immediately below Rima. We were to start early on the morning of August 16 for the alpine pastures. It was about 8 p.m. by (our) local time, roughly three-quarters of an hour after dark on a hot, close night, the stars shining brightly up and down the arid gorge. My wife was in bed, our two servants were in their tent, and I was seated writing my diary near the entrance to our tent.

Suddenly, after the faintest tremor (felt by my wife but not by me) there came an appalling noise, and the earth began to shudder violently. I jumped up and looked out of the tent. I have a distinct recollection of seeing the outlines of the landscape, visible against the starry sky, blurred—every ridge and tree fuzzy—as though it were rapidly moving up and down; but fifteen or twenty seconds passed before I realized that an earthquake had started. My wife shouted: "Earthquake!" before I did, and leapt out of bed. Together we rushed outside, I seizing the oil lantern which I placed on the ground; I was conscious of fearing that the tent would catch fire. We were immediately thrown to the ground; the lantern, too, was knocked over, and went out instantly.

I find it very difficult to recollect my emotions during the four or five minutes the shock lasted; but the first feeling of bewilderment—an incredulous astonishment that these solid-looking hills were in the grip of a force which shook them as a terrier shakes a rat—soon gave place to stark terror. Yet my wife and I, lying side by side on the sandbank, spoke quite calmly together, and to our two Sherpa boys who, having already been thrown down twice, were lying close to us.

The earthquake was now well under way, and it felt as though a powerful ram were hitting against the earth beneath us with the persistence of a kettle-drum. I had exactly the sensation that a thin crust at the bottom of the basin, on which we lay, was breaking up like an ice floe, and that we were all going down together through an immense hole, into the interior of the earth. The din was terrible; but it was difficult to separate the noise made by the earthquake itself from the roar of the rock avalanches pouring down on all sides into the basin.

Gradually the crash of falling rocks became more distinct, the frightful hammer blows weakened, the vibration grew less, and presently we knew that the main shock was over. The end of the earthquake was, however, very clearly marked by a noise, or series of noises, which had nothing to do with falling rocks. From high up in the sky to the north-west (as it seemed) came a quick succession of short, sharp explosions—five or six—clear and loud, each quite distinct, like 'ack-ack' shells bursting. It was the 'cease-fire'.

After about half an hour we returned to the tent. I noticed that the travelling clock on the table and my watch were both going; the altimeter still registered 5,000 ft. exactly, and the thermometer outside under the fly showed 73° F. Nothing inside the tent was disturbed, except that a glass of water had been upset. The tents were pitched on a small sandbank about 600 yd. from the high bank of the La Ti torrent, rather more from the Lohit River. The nearest mountainside was 300–400 yd. to the east of us, and, as it happened, that particular face

did not slip badly; at any rate, no boulders reached us, or even the village. We could not have selected a safer site in an earthquake!

Within two hours the air was so thick with dust that every star was hidden; we breathed dust, it gritted our teeth, filled our eyes. Within a week every leaf of every tree and bush was caked with dust. Violent tremors continued all night, and twice we rushed outside—though the tent was perfectly safe. I slept intermittently for three hours; my wife not at all.

As soon as it was light, we dressed and went out to see what had happened. In the village every house had lost its roof of wooden slats, and every lean-to had been thrown down. The main irrigation channel was blocked, and the paddy fields with their standing rice would soon be dry. Farther afield, the small wooden monastery lay on its side, a bottle-shaped *chorten* had been stripped down to its axis, and a *mani* wall of flat inscribed stones had collapsed. I noticed that most of these structures had been thrown down towards the east, as though the push had come from the west.

Long fissures cut across the stony fields, running for the most part parallel with the river bank, past or present. In some places numerous fissures lay close together; elsewhere far apart. It appeared to depend on the nature of the soil, whether sandy or clayey. These cracks were rarely more than a few inches wide and two to four feet deep. Every well-trodden path was cracked throughout its length. Here and there a small block of land had sunk bodily.

The La Ti torrent was an extraordinary sight. The previous day the sparkling water, of a beautiful blue-green tint, revealed every boulder as it flowed swiftly down its rocky bed. Now it was dark coffee-coloured, but so thick with foam that it looked like *café-au-lait*. It had risen nearly four feet, and the muffled grinding of submerged boulders sounded ominous. The water smelt unpleasantly of mud, but I could detect nothing sulphurous about it. Three watermills, housed in timber cabins, had been smashed.

The Lohit had also risen, and the swift stream carried along great quantities of pine logs, which were already beginning to jam. The Rong Thō Chu was bringing down much more debris than the Zayul Chu, and the visible destruction up the former valley seemed to be greater than in the latter. (I have long held, contrary to the maps, that the Rong Thō Chu, which rises among glaciers, is the main stream. Its valley is also more thickly forested.) However, following up the Zayul River for half a mile, I soon reached a road block where a cliff had come down.

Day after day, night after night, tremors followed each other. Many of them were severe, and were always preceded by a short roar, like a distant thunder clap. The weather was sultry, the maximum shade temperature often more than 95°, until a wet spell between August 23 and 27 brought it down; the minimum was usually about 65°. On fine days a breeze blew from the south, but in the Rima basin it was so charged with fine dust, and so hot, that it brought no relief. By midday, as the rock avalanches began to fall, a vast dust cloud hid the sun, or dimmed it until it looked like a copper plate. Dust also mingled with the gathering thunderheads, and visibility was reduced to a mile or two.

No one was killed in Rima, but cattle and pigs were injured or killed by falling timber; in the river, great numbers of fish were killed, though few were taken from those raging waters. The indifference, or fatalism, of the local population (nominally Buddhist) was superb. The day after the earthquake they went about their work in the fields as though nothing had happened. Yet many of them seemed to think there would be a repetition of the major shock, and that next time they might all be killed. We could find no one who recollected a previous earthquake. With their houses exposed to the weather, they slept in temporary shelters made out of boards; and mending their roofs in the evenings, our village at least looked normal again after a fortnight.

The rope-bridge across the Lohit had been broken, and until another rope was constructed and fixed in position we could not leave Rima. Our chief anxiety was potable water, and this proved something of a problem until we discovered a spring in the bank of the Lohit.

As for the mountains which enclose the basin, they had everywhere been badly mauled. Wide belts had been ripped off, carrying trees and rocks; whole cliffs had crashed down, deep wounds scored; and everywhere rocks continued to cascade down hundreds of gullies. The damage done in the main Lohit valley was bad enough; that done in the tributary valleys, where every stream had to break through a narrow gorge thousands of feet deep, was infinitely worse. The destruction extended to the very tops of the main ranges—15,000-16,000 ft. above sea-level. No wonder the mountain torrents began to flow intermittently as the gorges became blocked, followed later by the breaking of the dam; whereupon a wall of water 20 ft. high would roar down the gulley, carrying everything before it and leaving a trail of evil-smelling grey mud.

Everywhere the scraped cliffs glistened white in the sunshine. Fallen boulders showed that by far the most abundant rock is granite, containing tiny nuggets of black mica evenly distributed through it; occasionally the mica is in excess. Quartz veins ramify through the rock in all directions and are of frequent occurrence; and an abrupt change in the size and nature of the crystals, without any cleavage plane, is not infrequent. Not far from our camp was an outcrop of sandstone and schist with secondary white mica. A cliff of this had broken away and buried the main irrigation flume. But this type of rock was not met with elsewhere.

The Rima men made several attempts to fix the rope bridge and establish connexion with the right bank; but it was not until September 6 that they succeeded. Meanwhile no news came, and only a few wild rumours (based on occasional conversations shouted across the Lohit) reached us. When we left for Walong on September 7, together with a patrol of the Assam Rifles who had joined us a fortnight after the earthquake, we had only a few days food in hand.

We reached Walong Outpost on September 11 after a risky journey, and any hope that below Rima the earthquake might have done negligible damage was quickly dispelled. (We did not yet know, of course, that we had been at the epicentre, or that we had survived one of the greatest earthquakes in history.)

It would be incautious at this stage to state categorically that the annual burning of the pine forest for the last fifty years, between Walong and Rima, was responsible for the huge damage done in the arid Lohit valley; but it seems certain that any further burning will prove completely disastrous. Even without the annual fires, the Lohit valley is likely to be a perilous place for some years.

NEW ASPECTS OF THE METAMORPHOSIS OF INSECTS

By V. J. A. NOVAK*
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ON the basis of experiments on *Oncopeltus fasciatus* Dall., started at the suggestion of Dr. V. B. Wigglesworth, I have reached conclusions which throw new light on the interaction of the metamorphosis hormones and the problem of morphogenesis in general.

Owing to its prominent black pattern, which is totally different in the last stage nymph and in the adult, the bug *Oncopeltus fasciatus* (Lygæidæ) has proved very suitable for the study of morphogenesis. The results of the experiments agree fully with those obtained by Wigglesworth in *Rhodnius*. Implantation of the heads of embryos has shown, in agreement with the findings of Pflugfelder[1] in the stick-insect *Dixippus morosus*, that the production of juvenile hormone has already begun in the late embryo. Transplantation of corpora allata from adult female cockroaches into last-stage nymphs of *Oncopeltus* has demonstrated the non-specificity of the juvenile hormone among different orders of insects.

The juvenile forms, intermediate between nymphs and adults, which were obtained, made it possible to study in great detail the morphogenetic changes that occur during metamorphosis in this species. As a result of these investigations, the existence of an intracellular growth factor, the 'gradient factor', has been suggested. The chemical nature of this factor is not known; but there is some reason for supposing that it may be concerned in tissue respiration. Its morphogenetic function would then depend upon its successive inactivation by specific compounds ('organizors' perhaps) in different cells in different tissues[4]. This 'gradient factor' provides a simple explanation of the mode of action of the two other metamorphosis factors, the 'moulting hormone' and the 'juvenile hormone' of Wigglesworth[2–5]. This explanation is, in fact, a further development of the ideas of Wigglesworth with a few modifications, and it clears up the confusion caused by those authors who insist on the existence of what they call the 'growth and differentiation hormone'[7,8]. I have succeeded in arriving at a theory of metamorphosis, incorporating all the known facts, which seems to give a complete causal explanation of this phenomenon, and which overcomes the contradictions in the conceptions put forward by various authors. The theory may be briefly summarized as follows.

Analysis of the changes in shape, structure and pattern which occur in *Oncopeltus* during metamorphosis has shown that allometric growth is a principal feature of metamorphosis, whereas harmonic growth is characteristic of larval development. Allometric growth depends on the loss of the capacity for further growth in some parts of the body, which therefore remain larval and do not change during metamorphosis or are even broken down by histolysis. Consequently, the entire food supply of the body, increased still further by material from the histolysed cells, is at the disposal of those parts of the body which continue to grow and which therefore become imaginal. Growth in these parts is thus strongly stimulated, and they form most of the future adult body.

Larval harmonic growth is proportionate growth of all parts of the body. It depends on a prolongation of growth activity in those parts of the body, or of those cells, which would not otherwise grow—it depends, that is, on the continued growth of the larval parts of the body. Transplantation of corpora allata into the last stage nymphs[3] and allatectomy in larvæ[9] have shown that the factor which conditions this harmonic growth is the juvenile hormone. Its function thus depends on the induction of growth. The increased food requirements of the larval cells which are induced to grow is inevitably associated with a reduction in the food supply for the imaginal parts of the body; their growth is thus slowed down and the result is proportionate growth.

In this way it is possible to explain the apparent contradiction between the inhibitory effect of the juvenile hormone on the imaginal characters, and its positive influence on the growth of such exclusively imaginal structures as the accessory glands of males and the ovarian follicles of females[3], together with its function in favouring metabolism in general as found by Pfeiffer[10] and Thomsen[11].

Now, since the growth of some parts of the body may be induced by a single, or at least a physiologically individual substance, the juvenile hormone, there is not the slightest reason for assuming that more than one factor is necessary for the induction of growth in the future imaginal cells. It is on these grounds that the conception of a growth factor contained in the cells and spreading by contact seems to be fully justified. This substance is termed the 'gradient factor'; it is supposed to be contained originally (that is, before the production of the juvenile hormone starts in the late embryo) in all cells of the body. (Its relation to the embryonic growth inductor is not yet clear, but there is not necessarily any qualitative difference between the two.) During larval growth it is consumed in the cells of the different parts of the body at different rates according to their chemical composition. In the future imaginal cells, it retains its activity up to the beginning of metamorphosis. In the larval cells the gradient factor is lost at an early stage; but this loss is not apparent until the last larval stage because, until that time, they are being supplied with a growth factor, the juvenile hormone, which is carried by the blood.

The evolution of the juvenile hormone may now be simply explained. The juvenile hormone is nothing but the growth factor in the corpora allata. The over-production of the growth factor by this organ leads to its becoming diffused in the blood. When it reaches a certain minimum concentration in the blood, the growth of all those cells of the body which come into contact with it is induced. The growth of the imaginal cells has, of course, already been induced by the gradient factor contained within them. The evolution of the juvenile hormone from the gradient factor was thus indubitably the first change (aromorphosis of Severcov[13,12]), which led to the development of metabolic insects in the Middle Palæozoic era and which created the conditions for all other improvements of this group.

The only function of the 'moulting hormone' of Wigglesworth[2] (= 'metamorphosis hormone' of Bodenstein[14] and others, *Verpuppungshormon* and *Imaginal-Häutungs-Hormon* of Kühn and Piepho[15], 'growth and differentiation hormone' of Scharrer[7], etc.) is thus the induction of the moulting process. This has been shown by Kopeć[16] and Wigglesworth[2].

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Both processes are interdependent to a high degree: no differentiation and no notable growth is possible without the loosening of the old inexpansible cuticle. On the other hand, feeding at the beginning of the instar provides the impulse not only for growth but also for the production of the moulting hormone. The mutual dependence is still more complicated in the Diptera Cyclorrapha, where both juvenile hormone and moulting hormone are produced by the same organ, the ring gland. Hence the confusion between the moulting and 'growth and differentiation' functions of the moulting hormone in the papers of Vogt[17], Bodenstein[14], Scharrer[7,18], Williams[8,19], etc. By the succession of moulting processes larval growth and metamorphosis are divided into a series of well-defined instars with periodically inhibited growth.

As a certain minimum concentration of the juvenile hormone in the blood is necessary to induce the growth of larval cells, there is a period in each instar before this minimum level is reached, during which only the cells containing the gradient factor, that is, imaginal cells, are able to grow. This is the period of allometric growth; hence the relative increase of the imaginal parts (the wing pads in *Oncopeltus*, the imaginal buds in Holometabola) in the later larval stages. The relative length of this period is determined by the time required for the production of the juvenile hormone to reach a certain minimum level, and this depends on the productivity of the corpora allata. As this productivity, *ceteris paribus*, is in direct proportion to the ratio of surface to volume in the gland (there are no blood capillaries inside the organ) and the surface increases with the square of the radius whereas the volume increases with the cube, there must be a decrease in the productivity of the corpora allata, and thus an increase of the allometric growth period with each succeeding instar. (The relation may be illustrated by the formula $P = c\,\frac{S_a V_a}{V_b}$, where P is the volume-independent productivity (the quantity of juvenile hormone in unit blood volume produced in unit time), c is a constant, S_a is the surface of the corpora allata, V_a is the volume of the corpora allata, and V_b is the volume of the blood.) Sooner or later, according to the species, an instar must be reached, during which the minimum level of the juvenile hormone is not attained before growth is inhibited by the newly deposited cuticle. This will therefore be the last larval instar, and metamorphosis will occur. It is this mechanism which determines the number of instars. The production of juvenile hormone by the corpora allata continues in the adult insect, but the productivity or rate of production decreases still further. There is morphological evidence of this in *Oncopeltus*. In the 4th stage nymph, the maximum volume of the corpus allatum is reached in about two days, in the 5th or last stage the increase is much smaller and the maximum is reached in about four days; in the adult insect the maximum is reached in eight to twelve days.

This theory, based on experiments with the heterometabolous *Oncopeltus*, may also be applied to the metamorphosis of Holometabola including Diptera, as a subsequent analysis of the results of different workers has shown. By means of this theory a simple causal explanation has been achieved of the nature of histolysis, the development of the pupal stage, hypermetamorphosis, regression metamorphosis and some other not yet fully understood phenomena. It leads further to some interesting generalizations enabling a deeper insight to be gained into the problems of growth and differentiation[20].

I wish to thank Dr. V. B. Wigglesworth, in whose department most of this work was carried out, for his continued interest and for much helpful discussion.

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SPECTROSCOPY AT RADIO-FREQUENCIES

AMSTERDAM CONFERENCE

THE Amsterdam Conference on Spectroscopy at Radio-Frequencies (September 18–23) was the third of three biennial conferences organized by the Netherlands Physical Society in co-operation with the International Union of Pure and Applied Physics. The previous meetings were the Zeeman Congress (1946) chiefly on optical spectroscopy, and the Conference on the Physics of Metals (1948). Those who had attended either of these previous events looked forward with pleasurable anticipation to the Conference of 1950, knowing that none could be more delightfully organized. The achievements of our Dutch friends in this respect might well be taken as a model in other countries, where an over-crowded programme is apt to straggle belatedly to a close before a jaded audience.

The development of radio-frequency spectroscopy in the past five years has been prodigious, and owes not a little to the fact that many physicists had their attention forcibly directed to radio and radar techniques during the Second World War. Previously the resonant absorption of energy (as distinct from non-resonant absorption in electrically polar or paramagnetic liquids and solids) had been detected only by molecular beam techniques, and applied to the precise determination of nuclear moments by Rabi and his school. These methods constituted a major experimental *tour de force* and involve the detection of resonance through its effect on the path of an atomic beam. The several branches of radio-frequency spectroscopy developed after the War are more akin to optical spectroscopy in that the actual absorption of energy from the radiation is measured. In 1946, at the Zeeman Congress, one paper on one aspect of these new methods was included; in 1950 a whole conference was devoted to this subject.

The scope of the Conference may be summarized by the sectional headings of the official programme. These were: paramagnetic resonance, ferromagnetic resonance, nuclear resonance, atomic and molecular

spectra and nuclear properties. The latter took the form of an exposition of the present theory of nuclear shell structure by Prof. L. Rosenfeld; its inclusion in this Conference underlined the fact that the several fields of research discussed (with the exception of ferromagnetic resonance) each contained notable contributions to nuclear data. In particular, the methods which have determined nuclear constants with an accuracy exceeding that of many atomic constants were well represented, as these without exception make use of radio-frequencies. In the following notes, a number of the novel and interesting results revealed at the meetings will be briefly discussed. Inevitably, this discussion must be inadequate, and many important papers omitted—in particular, Prof. Rosenfeld's survey, the session on experimental methods, and the excellent introductory talk with which Prof. C. J. Gorter opened the Conference.

A session of outstanding interest was that in which the chief two protagonists of nuclear induction and nuclear resonance diverted their audience with the most recent achievements of their laboratories. Prof. F. Bloch contrasted the smallest cyclotron in the world (8 cm. in diameter) at Stanford University, in which protons are being slowed down, with the machines under construction "by his friends across the bay". With this novel cyclotron and a nuclear induction experiment in the same magnetic field, the ratio of the proton magnetic moment to the nuclear magneton is determined from the ratio of the resonant frequency for the proton spin to the cyclotron frequency. The retarded protons finally take a considerable fraction of a radio-frequency period to cross between the 'dees', so that little energy is given up to the radio-frequency field; thus they make many revolutions, and high accuracy is attained, which is further enhanced by the use of radio-frequencies which are odd harmonics of the fundamental cyclotron frequency. The interim value of the ratio μ_p/μ_n is $2{\cdot}79245 \pm 0{\cdot}0002$. Other work at Stanford included the determination of a large number of nuclear moments by Proctor and Wu, using a recording spectrometer. The importance of chemical effects, such as a 1·3 per cent shift in the cobalt resonance between different compounds, was emphasized. The splitting into five components of the antimony resonance from each of the antimony isotopes in a solution of potassium fluorantimonate points to a quasi-crystalline structure in the liquid state.

Prof. E. M. Purcell's paper was concerned with nuclear relaxation effects in crystals. After considering the effect of molecular and ionic rotations on the relaxation time and line width, he described an experiment of Pound where, by use of the saturation phenomenon, it was shown that the spin-lattice relaxation is due to interaction between the nuclear electric quadrupole moment and the fluctuating electric field set up by vibrations within the crystal lattice. The theory of this process, adapted from that of Waller, led to relaxation times in reasonable agreement with experiment. The discovery of a fluoride crystal with a relaxation time of many minutes made possible several ingenious and fascinating experiments. By the use of a condenser discharge, the magnetic field could be reversed in a time short compared with the nuclear precession frequency; the polarization is then in the opposite direction to the field, with more nuclei in the state of higher energy than in the state of lower energy. This corresponds to a 'negative temperature', for which concept thermodynamic justification was claimed. Here it should be noted that the nuclei 'cool off' from negative temperatures to positive temperatures by passing through *infinite* temperature (equal populations of the two levels), not through the absolute zero. By observing the emission from such a crystal in fields less than the internal field, the answers to some interesting questions about the state of such a system can be obtained.

In a short communication Prof. H. Kopfermann gave details of the nuclear absorption lines observed by Kruger in zero magnetic field in solid compounds of iodine and chlorine. The frequencies of these lines are determined by the large electric quadrupole interaction and involve searching over a wide range of frequencies, up to 300 Mc./s. The ratio of the quadrupole moments of the two chlorine isotopes (35 and 37) obtained by this method is 1·2667, compared with 1·270 (Townes, microwave gas spectroscopy) and 1·280 (Zacharias, molecular beams). It is thought that the probable error in the last-quoted figure is greater than previously assumed; the ratio of the magnetic dipole moments obtained by Zacharias (1·2027) is also at variance with the nuclear induction result (1·2014) of Proctor and Wu.

A survey of recent advances in atomic beam techniques was given by Prof. P. Kusch, beginning with an account of the methods used by Zacharias to determine the spins and moments of several radioactive nuclei. Very precise measurements of the hyperfine structure of hydrogen, deuterium and tritium at Columbia University were outlined. The ratio of the hyperfine splitting of hydrogen and deuterium differs from the ratio calculated from the nuclear moments by $(1{\cdot}703 \pm 0{\cdot}007) \times 10^{-4}$; this is due to the effect of the internal nuclear motions in deuterium, a theoretical estimate of which gives $(1{\cdot}83 \pm 0{\cdot}22) \times 10^{-4}$ for the discrepancy. Prof. N. F. Ramsey described a method of using two radio-frequency fields to enhance the precision of molecular beam methods by a method analogous to the Michelson stellar interferometer.

The use of the isotope shift in rotational lines in microwave molecular spectra to determine nuclear masses was outlined by Prof. C. H. Townes. Frequencies can be measured to one part in 5×10^6; but a correction must be made for the change in the equilibrium distance between the atoms due to the different zero-point energy of different isotopes. Where several isotopes are available this correction can be calibrated from the masses of two isotopes, and the masses of the others determined with an accuracy exceeding that of the mass spectrograph. In this way it has been shown that neither for selenium nor germanium is there any anomaly in the mass where the closed neutron shell at $N = 40$ occurs. The spins of a number of nuclei, including several radioactive isotopes, have been established by means of the quadrupole interaction, and very small quantities were required (10^{-10} gm. in the case of sulphur-36). Using the Zeeman effect, Dr. C. K. Jen has determined the magnetic moment of sulphur-33 as $0{\cdot}63 \pm 0{\cdot}02$ nuclear magneton, together with the magnetic moment associated with molecular rotation of a number of compounds.

The study of paramagnetism by means of the resonance phenomenon at centimetre wave-lengths was reviewed by Dr. B. Bleaney. The presence of hyperfine structure in paramagnetic ions in the solid state was first suggested by Prof. C. J. Gorter, and verified by the late Dr. R. P. Penrose at Leyden at

the end of 1948. Following measurements at Oxford on copper, cobalt, manganese and vanadium salts, the principal features of the phenomenon have been reconciled with theory by the work of Abragam and Pryce. The spins of the two odd isotopes of neodymium (143 and 145) have been established as 7/2 and the ratio of their magnetic moments is 1·61. In the field of ferromagnetic resonance, the state of the theory was outlined by Prof. J. H. Van Vleck; the principal features which remain unexplained are the departure of the spectroscopic splitting factor from 2 in materials where the gyromagnetic ratio is very close to 2, and the cause of the width of the resonance lines. On the experimental side, Dr. J. H. E. Griffiths showed how, with the help of a new type of magnetometer, anomalous results with thin nickel films have been established as due to strain.

During the week, members of the Conference had opportunities of visiting the laboratories in Amsterdam, Delft, Utrecht and Leyden. The visit to Leyden coincided with the presentation of the first Kamerlingh Onnes Medal of the Nederlandsche Vereeniging voor Koeltechniek to Prof. F. E. Simon, of Oxford, in recognition of his outstanding contributions in the field of low-temperature research (see *Nature*, June 24, p. 1001). The occasion was marked by a dinner, and a reception by the British Council in Amsterdam on the following day. This was an addition to the many other social functions. This note cannot end without a tribute to the hospitality of the Netherlands Physical Society and the work of its Conference committee, in particular, the president, Prof. C. J. Gorter, and the secretary, Prof. J. de Boer.

B. Bleaney

OBITUARIES

Prof. J. F. Spencer

Prof. James Frederick Spencer, emeritus professor of chemistry in the University of London (Bedford College), who died on December 31 on the eve of his seventieth birthday, will be remembered by his former colleagues and by a large number of his students as a very human personality. One of his great pleasures was in university committee or examination work, when he met and worked with a body of other people. He enjoyed being in a laboratory full of students, with whom he discussed any topic that seemed to him appropriate. His popularity among his students at Bedford College was shown by the attendance at his farewell party in 1946. His colleagues recognized him as a man who had exerted all his powers to advance the academic prestige of the College, and they too, when he retired, felt that a real human link had been sundered.

Spencer took first-class honours in Liverpool in 1901 and, with the aid of an 1851 Exhibition, went to Breslau, where he worked for two years on a physico-chemical problem under Abegg and took the degree of Ph.D. The third year (1905–6) of the Exhibition he spent at University College, London, and was then appointed demonstrator in the Department of Chemistry at Bedford College, Mr. Holland Crompton then being the head of the Department. Here, as was customary in those spacious days, Spencer lectured on both organic and physical chemistry. As a result of Mr. Crompton's periodical absences through illness, the running of the department devolved from time to time on Dr. Spencer, and he became successively assistant lecturer and university reader in physical chemistry. In 1919 the Department of Chemistry was subdivided and he became head of the Department of Inorganic and Physical Chemistry. Eight years later he was granted the title of professor in the University of London and, in 1928, when a new head of the Department of Organic Chemistry was appointed, he also became director of the Chemical Laboratories. In 1929 he entered into occupation of the new Inorganic and Physical Laboratories, which are a living witness to his energy and foresight.

Spencer served Bedford College with whole-hearted zeal. He also did much to advance the study of magneto-chemistry, for which subject, particularly in collaboration with Dr. V. C. G. Trew, once a student and later a colleague, he acquired international recognition. He also wrote good books on practical physical chemistry and on the rare earths. In his spare time, he was an enthusiastic philatelist.

Miss W. S. Blackman

Miss Winifred Susan Blackman, who died on December 12, was one of the first women to adopt anthropology as a profession. After taking the diploma in anthropology in the University of Oxford, she worked for a time as assistant to Henry Balfour, then curator of the Pitt Rivers Museum, Oxford, where she is remembered for her careful cataloguing, especially of the large series of amulets and charms. This gave her an informed interest in magico-religious ideas and practices which she retained throughout her life, and put to practical use in her field-work.

In 1920–21 Miss Blackman worked in Egypt as research student to the Oxford Committee for Anthropology, returning for further periods during 1922–26 in charge of the Percy Sladen Expedition and again during 1927–31 under the auspices of the Wellcome Historical Medical Museum, for which she made extensive collections. Her main object was to study the daily life, beliefs and customs of the Egyptian peasantry, among whom she lived and whom she knew and understood as no one else has done. Her book, "The Fellāhīn of Upper Egypt", published in 1927, is still the most authoritative work on the subject, and has the rare quality of appealing alike to the specialist and to the layman. In the chapter on ancient Egyptian analogies, she had the advantage of the specialized knowledge of her brother, the distinguished Egyptologist, Prof. A. M. Blackman. It was a source of great satisfaction to her that by her researches into modern customs she was able to throw light on points hitherto obscure to students of ancient Egypt.

Her other publications, dealing with special aspects of her work in Egypt, are in the form of articles in various scientific journals, including the *Journal of Egyptian Archæology*, *Folk-Lore*, *Man*, and the *Journal of the Royal Anthropological Institute*. Although small in quantity, her published contribution to anthropology is valuable for its careful and detailed recording and scientific interpretation of data in a field where specialists are few. It is greatly to be regretted that circumstances prevented her from fulfilling the ambition recorded in the preface to her book, "to produce a large and strictly scientific volume on the beliefs and practices and the social and industrial life of the modern Egyptians".

Beatrice Blackwood

NEWS and VIEWS

United States National Bureau of Standards: Dr. E. C. Crittenden

Dr. Eugene Casson Crittenden, associate director of the United States National Bureau of Standards, has retired after more than forty-one years of service at the Bureau. Dr. Crittenden graduated at Cornell University in 1905 and went to the Bureau in 1909 as an assistant physicist in the Photometric Laboratory. His administrative ability was soon recognized, and in 1921 he became chief of the Electrical Division, continuing in this position for twenty-five years. On becoming assistant director in 1933, he was made responsible for the overall research activities of the Bureau, and, in addition, he played a prominent part on the Editorial and Personnel Committees. In 1946 he relinquished most of his immediate technical duties in order to devote himself more fully to general administrative functions as associate director. Dr. Crittenden is particularly noted for his achievements in the measurement and standardization of units of light, and for the establishment of absolute electrical units based on the fundamental units of length, mass and time. These electrical and photometric standards were internationally adopted in 1948. Among the honours he has been awarded are the Gold Medal of the Illuminating Engineering Society, the United States Department of Commerce Gold Medal Award for Exceptional Service, and honorary life-membership of the United States National Committee of the International Commission on Illumination.

Geological Society of London: Awards

The council of the Geological Society of London has made the following awards: *Wollaston Medal* to Prof. Olaf Holtedahl, of the University of Oslo, for researches on the mineral structure of the earth, especially on the Lower Palæozoic rocks of Norway, on Caledonian structural problems, and on geomorphology; *Murchison Medal* to Prof. W. B. R. King, of the University of Cambridge, in recognition of the value of his researches on Lower Palæozoic and Pleistocene stratigraphy; *Lyell Medal* to Dr. W. D. West, director of the Geological Survey of India, for researches on the Archæan rocks of India; *Bigsby Medal* to Prof. E. Sherbon Hills, of the University of Melbourne, for researches on the geology of Australia and especially on the extinct fish faunas of that continent; *Prestwich Medal* to Dr. H. Godwin, for outstanding work on the application of pollen analysis to the stratigraphy of the Pleistocene and post-Glacial deposits, and for leadership of the sub-department of Quaternary Research, University of Cambridge; *Wollaston Fund* to Mr. A. Greig, for long and distinguished services as assistant secretary of the Society and editor of its *Journal*; *Murchison Fund* to Mr. T. Deans, of the mineral resources division of the Colonial Geological Surveys, for work on sedimentary ironstone, the igneous rocks of Northern Rhodesia, and the lead-zinc deposits of Europe; a moiety of the *Lyell Fund* to Prof. R. T. Prider, of the University of Western Australia, for work on the mineralogy and petrography of the igneous and metamorphic rocks of Western Australia; another moiety of the *Lyell Fund* to Dr. F. H. Stewart, of the University of Durham, for work on basic igneous rocks and evaporites.

Institute of Metals: Awards

The Council of the Institute of Metals has made the following awards for 1951: *Institute of Metals (Platinum) Medal* to Dr. R. W. Diamond, vice-president and general manager of the Consolidated Mining and Smelting Company of Canada, Ltd., Trail, B.C., Canada, in recognition of his outstanding services to the non-ferrous metal industries in connexion with researches on differential flotation as applied to the complex Sullivan ore, and as manager of the largest combined copper and lead producer in the world; *W. H. A. Robertson Medal* to Mr. C. Smith, chief metallurgist, James Booth and Co., Ltd., Birmingham, for his paper on "The Extrusion of Aluminium Alloys" (*J. Inst. Metals*, **76**; 1950); *Walter Rosenhain Medal* to Prof. G. V. Raynor, professor of metal physics in the University of Birmingham, for his outstanding contributions in the field of physical metallurgy, in connexion with our knowledge of the constitution and formation of alloys; this is the first award of the Walter Rosenhain Medal.

J. J. Audubon (1785–1851)

John James Audubon, who died a century ago, on January 27, 1851, was born in Santo Domingo, Haiti, on April 26, 1785. He began to make sketches of birds when only fifteen years of age, and in 1804, on his father's estate near Philadelphia, he carried out the first 'banding' experiment conducted in the United States. His various commercial ventures failed largely because of his fondness for roaming the countryside, observing and sketching birds. In the winter of 1819–20 he worked for a time as taxidermist at the new Western Museum in Cincinnati. In search of subscribers for his monumental work, "The Birds of America", Audubon visited Europe and was lionized in Edinburgh. The first part of the elephant folio edition appeared in 1827, while the accompanying text was written with the assistance of William MacGillivray during 1831–39. "Viviparous Quadrupeds of North America", prepared in collaboration with the American naturalist, John Bachman, was completed by Audubon's two sons. Though elected a fellow of the American Academy of Arts and Sciences and acclaimed as the foremost naturalist in the United States—there was an Audubon tradition even before his death—Audubon's work was criticized by both men of science and artists. In the centennial month of his death he is gratefully remembered as one who, without any scientific training, aroused the interest, and won the heart, of the world by the engaging vitality of his paintings. His memory is kept green by Audubon societies throughout America.

William Stirling (1851–1932)

William Stirling, who was born a century ago, on January 26, 1851, was one of the early professional physiologists in Great Britain when this subject was inadequately taught in many medical schools. After graduating at the University of Edinburgh with first-class honours in science and medicine, he studied under Carl Ludwig in Leipzig, and with Louis Antoine Ranvier in Paris. At the early age of twenty-six Stirling was appointed regius professor of the Institutes of Medicine at Marischal College, University of Aberdeen, and in 1885 he succeeded Arthur Gamgee as Brackenbury professor of physiology and histology in Owens College, University of Manchester. He was dean of the Medical Faculty during 1902–13. Though in his early postgraduate days he had done promising original research—he and Kronecker were

the first to observe the refractory phase of the heart in 1874—Stirling is remembered chiefly as an interpreter of the work of others, as an organizer and as a lecturer. The first edition of his translation of Leonard Landois's "Lehrbuch der Physiologie des Menschen" (1884) met a real need. His other books included "Outlines of Physiological Chemistry" (1881), "Outlines of Practical Physiology" (1888), "Outlines of Practical Histology" (1890) and "Some Apostles of Physiology" (1902). More than six feet tall and always immaculately dressed, William Stirling was an impressive personality and a fine speaker, who prepared his lectures with infinite care and illustrated them with a wealth of models and historical allusions. He retired in 1919 and died on October 1, 1932.

Committee on Growth and Form: Research in Anthropometry

THE Medical Research Council has appointed a Committee on Growth and Form, under the chairmanship of Prof. P. B. Medawar, Mason professor of zoology in the University of Birmingham, with the following terms of reference: "To advise and assist the Medical Research Council (*a*) in promoting research on the growth and form of the human body with particular regard to the provision of basic scientific data, including the elucidation of factors affecting the rate of growth of the whole body and of its parts and the establishment of norms of stature and weight for different ages and different sections of the population; and (*b*) in facilitating the application of such data to various practical problems, including such as arise within the field of clinical medicine". One of the Committee's first tasks is to make a review of work in the field of anthropometry. The Committee would accordingly be glad to have information about current or completed anthropometric surveys, including unpublished records, so as to avoid any unnecessary repetition of work and to ensure, if possible, that use is made of existing material. It is believed that there are in existence records of height, weight, and other body measurements, which, if analysed, could form the basis for research into growth and development. Serial records of the growth of the same children from year to year, as well as measurements which have been recorded over a long period of time, would be particularly valuable. The secretary of the Committee, to whom all communications should be addressed, is Mr. E. M. B. Clements, M.R.C. Committee on Growth and Form, Medical School, Hospitals Centre, Birmingham, 15.

Chemical Investigations on Cores collected from the Deep-sea Floor

A FUND has been established, with generous donations from Swedish commercial sources, to enable chemical investigations to be undertaken in the Department of Mineralogy of the British Museum, under the direction of Dr. J. D. H. Wiseman, on one or two of the long cores from the sea floor collected by the Swedish Deep-Sea Expedition in 1947–48, led by Prof. Hans Pettersson. The fund is administered by an Anglo-Swedish Committee consisting of Prof. Hans Pettersson (chairman), director of the Göteborg Oceanographical Institute; Dr. G. Ahlström, director of the Swedish Institute, London; Dr. L. H. N. Cooper, Marine Biological Association of Great Britain, Plymouth; Dr. W. Campbell Smith, Dr. M. H. Hey and Dr. J. D. H. Wiseman (secretary), all of the Department of Mineralogy, British Museum (Natural History). The Committee has secured the services of Mrs. Anne Foster, who has previously carried out chemical research under Prof. L. S. Theobald, of the Imperial College of Science and Technology, London. In order to achieve a better understanding of geochemical cycles, it is necessary to have more information about the composition of the surface layer of the deep-sea floor, which covers approximately two-thirds of the earth's surface, as well as of the changes which take place with increasing depth below the surface layer. It would seem that in favourable places deep-sea cores will reveal a continuous record of past changes in the world's history. For example, Dr. Wiseman has recently shown that past climatic changes may be revealed and dated through investigations on deep-sea cores (*The Times*, Sept. 22, 1950). In view of the generous initial donations from Sweden—an excellent example of international scientific co-operation—and of the importance of this investigation, which leads into many unexplored fields, it is hoped that substantial additions will be made to this fund from British sources.

Possible Mechanism of Virus Reproduction

A USEFUL review of the mechanism of virus reproduction in bacteriophage, by S. E. Luria (*Science*, 111, No. 2889; May 12, 1950), makes use of the hypothesis that the virus introduces a completely predominant organizer of specificity into the bacterial cell, in what could be called parasitism at the genetic level. Infection disrupts the genetic organization of the host and changes the organization of the infecting virus, to form a new unit, the virus-infected cell. This contains the existing enzymatic machinery of the host and, "superimposed upon it, a genetic pattern derived from the virus and directing the synthesis of virus material from nonspecific building blocks". The author indicates certain parallels of this idea in animal viruses, and it might be added that the hypothesis is not at variance with what is known about certain plant viruses.

Research in the Small Firm

IN an address to the Autumn Management Conference of the British Institute of Management which was held at Harrogate in October 1950, Mr. W. E. Benton discussed the functions of the research department in a small firm. In a large organization the research department may be charged with the development of new products, the control and improvement of production processes, the testing of materials, components and complete production units, and the investigation of faults in products. In a small firm it is impossible to ignore the pressing claims of production problems, and the research department is often expected to investigate every problem of a technical nature which arises in the conduct of the firm's business. When the firm is particularly busy, production problems multiply, and the end of a boom period may find the development of new products very far behind the original programme. The research scientist himself should not only be well qualified academically but should have had some training in the use of tools and have appreciation of the qualities of materials and finishes; some artistic ability or an appreciation of good design is equally desirable. Mr. Benton also describes the way in which he thinks the research department in a small firm should be organized.

Low-Temperature Physics: Conference in Oxford and London

The second conference on low-temperature physics of the Unesco Commission for Very Low Temperatures will be held in Oxford during August 22–28 and in London during August 29–31. On August 21 the Royal Society Mond Laboratory, Cambridge, will be open to members of the conference. The meeting in Oxford will be devoted to pure physics only—liquid helium, superconductivity, magnetic phenomena and thermal properties. The meeting in London will form part of the conference of the Institut International du Froid and will consist of sessions on liquefiers and temperature scales, followed on August 31 by a general survey of the Oxford meeting. The conference of the Institute will be continuing until September 5 and is designed for those who are interested in the technical and industrial aspects of low temperatures. Intending speakers at the Unesco Commission conference should send in a short abstract of 150–200 words, preferably in June, and not later than August 1, and those who wish to attend the conference should intimate their desire as soon as possible. All inquiries should be addressed to the Organizing Committee of the Low Temperature Conference, Clarendon Laboratory, Parks Road, Oxford.

Colonial Service: Recent Appointments

The following appointments in the Colonial Service have recently been announced: W. H. Hale (administrative officer, Kenya), game warden, Kenya; B. G. Kinloch (administrative officer, Kenya), assistant game warden, Uganda; E. G. A. Benson (agricultural officer, Trinidad), rice officer, Trinidad; A. P. McWilliam (agricultural officer, Sierra Leone), agricultural officer, Nyasaland; J. R. P. Angus (assistant conservator of forests, Kenya), conservator of forests, Fiji; R. L. Brooks (chief conservator of forests, Gold Coast), secretary to the Ministry of Agriculture and National Resources, Gold Coast; G. W. Chapman (senior assistant conservator of forests, Cyprus), conservator of forests, Cyprus; R. W. J. Keay (assistant conservator of forests, Nigeria), forest botanist, Forestry Department, Nigeria; D. S. P. Noakes (senior assistant conservator of forests, Federation of Malaya), conservator of forests, Federation of Malaya; D. R. Rosevear (deputy chief conservator of forests, Nigeria), chief conservator of forests, Nigeria; D. Stevenson (deputy chief conservator of forests, Gold Coast), chief conservator of forests, Gold Coast; A. V. Thomas (research officer, Forestry Department, Federation of Malaya), chief research officer, Forestry Department, Federation of Malaya; J. R. Antoine, assistant plant pathologist, Mauritius; D. M. Grieve, agricultural officer, Nigeria; M. Dinning, assistant conservator of forests, Gold Coast; D. R. Gifford, assistant conservator of forests, Northern Rhodesia and Nyasaland; R. W. Fishwick and J. F. Pollard, assistant conservators of forests, Nigeria; C. R. Newing and W. Ferguson, veterinary officers, Nigeria; K. D. Guyadeen, agricultural superintendent, British Guiana; E. R. Haslop and R. F. Scott, agricultural survey officers (cocoa), Gold Coast; A. F. Rae, scientific assistant, Tsetse Control, Gold Coast; J. Ricketts, agricultural superintendent, Nigeria.

Letter from James Smetham to William Davies

Prof. F. J. Cole wishes to trace the MS. of a letter dated October 7, 1863, addressed by James Smetham, the painter, to William Davies, F.G.S. (1814–91), a member of the geology staff of the British Museum (Natural History), who retired in 1887. This letter was printed in the "Letters of James Smetham", published in 1892, on pp. 143–45. If it is still available, Prof. Cole would be grateful for any information as to its whereabouts. Communications should be addressed to Prof. F. J. Cole, F.R.S., Littledown, Kingwood, Henley-on-Thames.

The Night Sky in February

New moon occurs on Feb. 6d. 07h. 54m., U.T., and full moon on Feb. 21d. 21h. 12m. The following conjunctions with the moon take place: Feb. 4d. 15h., Mercury 4° N.; Feb. 7d. 22h., Venus 0·6° S.; Feb. 8d. 05h., Jupiter 0·5° S.; Feb. 8d. 06h., Mars 0·4° S.; Feb. 24d. 03h., Saturn 4° N. In addition to these conjunctions with the moon, Mars is in conjunction with Jupiter on Feb. 7d. 19h., Mars 0·2° N.; and Venus is in conjunction with Jupiter on Feb. 11d. 15h., Venus 0·4° S., and is also in conjunction with Mars on Feb. 16d. 04h., Venus 0·6° S. Mercury is a morning star, rising an hour before the sun on February 1, but as it gradually draws closer to the sun it is unfavourably placed for observation throughout most of the month. Venus, an evening star, sets more than two hours after the sun throughout most of the month, having stellar magnitude −3·3, and the visible portion of the illuminated disk varying from 0·95 to 0·90. Mars sets about two hours after the sun during the month; in the latitude of Greenwich the conjunction of the planet with Jupiter on February 7 takes place after their setting, but they can be seen close together previous to this. Saturn rises at 21h. 20m., 20h. 30m. and 19h. 30m., on Feb. 1, 14 and 28, respectively, and is visible throughout the night, close to η Virginis in the earlier part of the month and about midway between η and β Virginis towards the end of the month. Only one occultation of stars brighter than magnitude 6 occurs in February, namely, γ Canc. disappearing on Feb. 19d. 19h. 42·4m.

Announcements

The Royal Scottish Geographical Society has announced the award of the following medals: Livingstone Medal to Prof. Alan G. Ogilvie, of the University of Edinburgh, first professor of geography in Scotland, for outstanding services to that science; Mungo Park Medal to Thor Heyerdahl, for courage and enterprise in navigating the Kon Tiki Raft from South America to Polynesia.

Mr. W. C. F. Hessenberg, head of the Mechanical Working Division of the British Iron and Steel Research Association, has been appointed in addition to be deputy director of the Association.

Applications are invited for Lady Tata Memorial Fund grants and scholarships to scientific workers of any nationality for research in diseases of the blood, with special reference to leukæmia, in the year beginning October 1, 1951. Grants are made for research expenses, and scholarships are awarded as personal remuneration, their normal value being £400 a year. Applications must be submitted before March 31, and the awards will be announced in June. Further particulars and forms of application may be obtained from the Secretary of the Scientific Advisory Committee, c/o Medical Research Council, 38 Old Queen Street, Westminster, London, S.W.1.

SYNTHESIS OF FLUOROCARBONS, PERFLUOROALKYL IODIDES, BROMIDES AND CHLORIDES, AND PERFLUOROALKYL GRIGNARD REAGENTS

By Dr. R. N. HASZELDINE
University Chemical Laboratory, Cambridge

IN an earlier communication[1], the interaction of trifluoroiodomethane and tetrafluoroethylene was shown to yield compounds of general formula $CF_3(CF_2CF_2)_nI$. Members of this homologous series up to $n = 12$ have been isolated, and, since pentafluoroiodoethane with tetrafluoroethylene similarly gives $CF_3CF_2(CF_2CF_2)_nI$, a combination of the two series enables any of the compounds $CF_3(CF_2)_nI$ (n = 0–12) to be prepared.

A new method has now been found for the preparation of short-chain tetrafluoroethylene polymers, and on a large scale the reaction can be controlled to give a product of any desired chain-length more closely than is the case with trifluoroiodomethane or pentafluoroiodoethane and tetrafluoroethylene. The compound tetrafluorodiiodoethane, the preparation of which by the addition of iodine to tetrafluoroethylene was described earlier[2], readily liberates iodine on exposure to light at room temperature or on heating, and even on storage in the dark is slowly converted into iodine and a polymer having the characteristics of polytetrafluoroethylene. When tetrafluorodiiodoethane is heated with tetrafluoroethylene, an addition polymerization occurs and the compound $I(CF_2CF_2)_2I$ is readily isolated in high yield. This compound is also formed when tetrafluoroethylene and iodine are heated under pressure, and in both cases higher members of the series $I(CF_2CF_2)_nI$ are formed in amounts which can be varied by choice of temperature and pressure. The cyclic dimer of tetrafluoroethylene is a by-product in these reactions. It is somewhat more convenient, however, to carry out the reaction in stages, and it has been found possible to devise conditions to convert each member of the series into substantially the next higher member by reaction with tetrafluoroethylene:

$$I(CF_2CF_2)I \xrightarrow{C_2F_4} I(CF_2CF_2)_2I \xrightarrow{C_2F_4} I(CF_2CF_2)_3I \xrightarrow{C_2F_4}, \text{etc.}$$

At each step varying amounts of the compounds where two or more tetrafluoroethylene units have been added in one stage are formed. Such compounds are present in only small amounts when the lower members of the series are used, but as the chain-length increases, the further reaction with tetrafluoroethylene gives products with a greater spread in chain-length. At the present stage of the investigation, this stepwise addition has been carried out to give compounds with up to nine $-CF_2CF_2-$ units; while the stepwise addition can undoubtedly be carried on farther than this point, the volatility of the material and steric considerations make the spread of products larger, and the yield of the required compound where only one $-CF_2CF_2-$ unit has been added is consequently low.

The reaction mechanism suggested is as follows:

$$ICF_2CF_2I \xrightarrow{\text{heat}} ICF_2CF_2\cdot + \cdot I \quad \text{radical formation (1)}$$

$$ICF_2CF_2\cdot + CF_2{=}CF_2 \rightarrow ICF_2CF_2CF_2CF_2\cdot \quad \text{chain initiation (2)}$$

$$ICF_2CF_2CF_2CF_2\cdot + CF_2{=}CF_2 \rightarrow I(CF_2CF_2)_2CF_2CF_2\cdot, \text{ etc. chain propagation (3)}$$

$$ICF_2CF_2CF_2CF_2\cdot + ICF_2CF_2I \rightarrow ICF_2CF_2CF_2CF_2I + ICF_2CF_2\cdot \quad \text{chain termination (4)}$$

There is, as yet, no proof that the chain termination by radical combination does not occur, although termination by chain-branching, which would involve the fission of a carbon–fluorine bond, is considered unlikely. It is also possible that diradicals such as $\cdot CF_2CF_2\cdot$ play some part in the reaction:

$$\cdot CF_2CF_2\cdot + CF_2{=}CF_2 \rightarrow \cdot CF_2CF_2CF_2CF_2\cdot \xrightarrow{ICF_2CF_2I}$$

$$\cdot CF_2CF_2CF_2CF_2I + \cdot CF_2CF_2I$$

$$\downarrow ICF_2CF_2I$$

$$ICF_2CF_2CF_2CF_2I + ICF_2CF_2\cdot, \text{ etc.,}$$

and that iodine atoms can initiate the chain

$$I\cdot + CF_2{=}CF_2 \rightarrow ICF_2CF_2\cdot \xrightarrow{ICF_2CF_2I} ICF_2CF_2CF_2CF_2I + I\cdot$$

The precise mechanism has yet to be decided. It is noteworthy that when iodine is heated with excess tetrafluoroethylene the product obtained has a much longer chain-length (compounds with 10–20 and probably higher $-CF_2CF_2-$ units have been isolated) than when $C_2F_4I_2$, $C_4F_8I_2$, etc., are heated with excess tetrafluoroethylene, or when excess iodine is heated with tetrafluoroethylene under the same conditions.

The mechanism in equations 1–4 is similar to that proposed earlier[1] for the reaction between trifluoroiodomethane and tetrafluoroethylene, where it was assumed that the CF_3 radical initiates the polymer chain; studies on the reaction of trifluoroiodomethane with propylene and with vinyl chloride are in progress to determine the direction of addition in these cases and to ascertain that it is the CF_3 radical and not the iodine atom which initiates the reaction.

The compounds of general formula $I(CF_2CF_2)_nI$ have properties similar to the fluoroiodides $CF_3(CF_2)_nI$. The lower members are liquids and the higher members are waxy solids. The compounds with $n > 1$ are much more stable than $C_2F_4I_2$, where the iodine atoms are on adjacent carbon atoms, but the carbon–iodine bonds can be broken by ultraviolet light or heat to give the corresponding free radicals, which can then undergo reactions of the type shown by trifluoroiodomethane, pentafluoroiodoethane and heptafluoroiodopropane. They will, for example, undergo addition-polymerization reactions with ethylene[1] and with acetylene[3], and yield organometallic compounds[2,4,5].

By the replacement of one iodine atom by fluorine, the compounds $I(CF_2CF_2)_nI$ can be converted into fluoroiodides, $CF_3(CF_2)_nI$, identical with those obtained from trifluoroiodomethane and tetrafluoroethylene. This is conveniently achieved by treatment with

iodine pentafluoride, antimony pentafluoride, or fluorine diluted by nitrogen. Reaction with diluted fluorine (which tends to cause carbon–carbon bond fission), with iodine pentafluoride, iodine heptafluoride, or antimony pentafluoride in an autoclave, or passage over heated cobalt trifluoride, converts both the perfluoroalkyl diiodides and the perfluoroalkyl monoiodides into the corresponding fluorocarbons in high yield, and representative fluorocarbons up to $C_{18}F_{38}$ have thereby been obtained. This represents a convenient method for the synthesis of fluorocarbons, since although $C_{14}F_{24}$ has been prepared by reaction of cetane with fluorine or cobalt trifluoride[6], the decomposition occurring during the fluorination of paraffins with more than nine carbon atoms is appreciable.

The iodine atoms in the compounds $I(CF_2CF_2)_nI$ and $CF_3(CF_2)_nI$ are 'positive', as they are in trifluoroiodomethane and pentafluoroiodoethane[7,8], and can be replaced by hydrogen by treatment with alcoholic alkali; this replacement can also be effected by irradiation in the presence of solvents (for example, hydrocarbons, alcohols, ethers) from which hydrogen is readily abstracted by the fluoroalkyl radicals formed.

Photochemical or thermal bromination or chlorination of the compounds $I(CF_2CF_2)_nI$ yields $Br(CF_2CF_2)_nBr$, or $Cl(CF_2CF_2)_nCl$, and small amounts of $Br(CF_2CF_2)_nI$ and $Cl(CF_2CF_2)_nI$. For purposes of identification, the compounds of the last two mentioned series where $n = 1$ have been synthesized by the addition of iodine monobromide and iodine monochloride to tetrafluoroethylene. Representative compounds of formula $Br(CF_2CF_2)_nBr$ have been converted into $CF_3(CF_2)_{2n-1}Br$ by careful treatment with bromine trifluoride. The perfluoroalkyl monobromides, which can also be obtained from $CF_3(CF_2)_nI$ by treatment with bromine, give fluorocarbons with excess bromine trifluoride or with antimony pentafluoride under pressure. The conversion of $Cl(CF_2CF_2)_nCl$ into $CF_3(CF_2)_{2n-1}Cl$ and $CF_3(CF_2)_{2n-2}CF_3$ is more difficult, but can be achieved, although in much poorer yield, by reaction with fluorine diluted by nitrogen, or with chlorine trifluoride or antimony pentafluoride under pressure. The first two reagents cause some degradation to fluorocarbons of lower molecular weight.

By mixing the long-chain fluorocarbons and fluorochlorocarbons synthesized as described above with each other, or with small amounts of liquid cyclic fluorocarbons of similar volatility prepared by the cobalt fluoride method[6], oils, greases and waxy solids are obtained which have the stability of the constituent compounds.

The chemistry of the compounds $CF_3(CF_2)_nI$ synthesized by the two distinct methods outlined above is being studied. It has been found that the lower members of this series form Grignard reagents $CF_3(CF_2)_{0-3}MgI$ which appear to behave normally, since on hydrolysis the compounds $CF_3(CF_2)_{0-3}H$ are produced, while after treatment with carbon dioxide the acids $CF_3(CF_2)_{0-3}COOH$ have been isolated. Furthermore, reaction with acyl chlorides gives the expected ketones, although in small yield. The conversion of the fluoroiodides into fluoroacids by an alternative route has been described earlier[9]. Little difference can be detected qualitatively between the reactivities of the iodine atoms in the series $CF_3(CF_2)_nI$ when n is greater than 1, and it would appear probable that the Grignard reagents of the higher fluoroiodides can also be obtained. Clearly, these are of synthetic value and open up routes to many compounds of interest. The conversion of the Grignard reagents to the still unknown primary perfluoroalkyl alcohols by treatment with oxygen, and their reactions with perfluoroketones (such as CF_3COCF_3) to give the corresponding tertiary alcohols, for example, are being studied. Full details of the reactions and syntheses described above will be published elsewhere. [Aug. 23.

Note added in proof. Prof. A. L. Henne, of Ohio State University, reports (private communication) that he has recently prepared C_3F_7MgI.

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RADIATION EFFECTS IN PLANT NUTRITION EXPERIMENTS WITH PHOSPHORUS-32

By Dr. C. BOULD, Dr. D. J. D. NICHOLAS and Dr. W. D. E. THOMAS
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THE application of radioactive isotopes to problems in plant nutrition is justified only when it is established that no serious injury occurs to the plants by radiation from 'tracer' materials during the experiments. It has recently been shown that, under certain conditions, young barley plants are damaged at very low radioactive levels: 10 μC. phosphorus-32 per litre in water culture[1], or 2 μC. per pot containing 2 kgm. of soil[2,3]. In experiments with cereals in soil culture, Spinks *et al.*[4,5] and Hendricks and Dean[6] used considerably higher levels of phosphorus-32, but they showed that the yields of cereal 'tops' were not affected by the radioactive fertilizers. Russell *et al.*[3] regard as essential an examination of the meristematic root tissue. They have shown that injury may occur without producing dry-weight changes in the above-ground parts of the plants, and they suggest, apart from a detailed microscopic examination, that changes in the values of certain ratios, for example, fertilizer phosphate uptake/soil phosphate uptake, for the plants with increased specific activity of phosphorus-32 per gm. phosphorus-31, may also provide indications of radiation injury.

Before using phosphorus-32 in plant nutrition studies, we have determined the magnitude of radiation effects in tomato and barley, grown in soil. We used different activities of radioactive phosphate, associated with two levels of carrier phosphate respectively, in replicated pot experiments. The following functions were determined: dry weights of the plant parts above and below ground respectively, their total phosphate content, fertilizer phosphate uptake, and various ratios derived from these. We define radiation effects as changes in any of these quantities which can be attributed to phosphorus-32. We have found that although radiation effects occur at very low tracer-levels, they are relatively small, and are in no way sufficient to preclude the use of

Table 1. Experiment 1. The Dry Weights of Barley Tops in Relation to Tracer-Levels

P^{32} as μC. per pot	400	150	25	5	1	0	L.S.D.
Dry weights (gm.): mean of 8 plots	2·759	2·903*	2·854*	2·890*	2·598	2·561	0·01 = 0·206

The interaction between phosphorus-31 and -32 was not significant. Values significantly different from the controls at the 1 per cent level indicated by asterisk *

phosphorus-32 in plant nutrition studies. The results seem to be of sufficient interest and importance to merit preliminary publication.

In the barley experiment, ten seeds (variety Spratt Archer) were sown at constant depth in each of 144 6-in. clay pots treated with bitumen and randomized in a large glasshouse. Each pot contained 1·95 kgm. of a medium loam soil derived from New Red Sandstone, with a *p*H of 6 and a citric-soluble phosphate value of 0·030 per cent. The carrier used was sodium dihydrogen phosphate at two levels equivalent to 200 and 500 lb. superphosphate per acre respectively. Both carrier-levels were labelled with each of the following activities: 0, 1, 5, 25, 150 and 400 μC. phosphorus-32 per pot as orthophosphate. These correspond to a range of specific activities of 23–23,000 μC. per gm. phosphorus-31. The chemical form of the phosphorus-32 was confirmed before use[7]. A supplementary nutrient solution of potassium sulphate and ammonium sulphate in 50 ml. was added a few hours after sowing, and the radioactive sodium dihydrogen phosphate (50 ml. per pot) the following morning. Three pots comprised one sampling unit, and there were four replicates for each of the twelve treatments. The plants were harvested twenty-two days after sowing. A special washing apparatus was used to remove the soil from the roots with minimum mechanical damage and loss of phosphate. The plants taken from each sampling unit of three pots were cut at soil-level into tops and roots. The tops and roots respectively were dried, weighed, digested with nitric and perchloric acids, and total phosphate determined colorimetrically[8]. The fertilizer phosphate uptake of each sample was determined by liquid counter (*M*6 tube[9]) with a statistical error of less than 2 per cent. The soil phosphate uptake of the plants was assumed to be equal to the difference between the total phosphate and the sum of fertilizer phosphate uptake plus the original phosphate content of the seed. The dry weights and fertilizer uptake of the roots and corresponding tops were determined separately as well as in combination. The following ratios were also calculated: fertilizer phosphate uptake/soil phosphate uptake, fertilizer phosphate uptake/total phosphate, fertilizer phosphate in tops/fertilizer phosphate in roots.

Statistical analysis showed that, whereas the dry weights of the roots are unaffected, the tops show significant changes at both carrier-levels of phosphorus-31.

A stimulating effect on dry weights of wheat tops is also shown in the data of Dion *et al.*[4] and was attributed by them to uneven germination. In our experiments, however, germination was good and the effects observed can be attributed only to the 'tracer'.

The fertilizer phosphate and total phosphate content of the roots and tops respectively and in combination showed no significant difference with 'tracer' level. The ratio of fertilizer phosphate top/fertilizer phosphate root was not affected. The ratios of fertilizer phosphate/total phosphate and fertilizer phosphate/soil phosphate uptake in the combined roots and tops are given in Table 2.

It is clear from the results given in Table 1 that significant differences in dry weights are shown from low radioactive levels, namely, 5 μC. per pot. The effects tend to reach a maximum with increased tracer-level, decreasing at higher levels. The fertilizer phosphate uptake/total phosphate and fertilizer phosphate uptake/soil phosphate uptake are just significant ($P = 0{\cdot}01$) at 400 μC. per pot only.

Further studies in the same soil were made with barley and tomato. In these experiments the same carrier-levels of phosphorus were used; but the tracer-levels were 0, 0·5, 4, 25 and 500 μC. phosphorus-32 per pot, corresponding to a range of specific activities of 12–29,760 μC. phosphorus-32 per gm. phosphorus-31. In the barley experiment, three 6-in. pots (10 seeds per pot) constituted a sampling unit with four replicates per treatment. Harvesting was done in the same way as described in the previous experiment, twenty-five days after sowing. Growth was less vigorous than in the previous experiment. The results show no significant differences in the dry weights of either roots or tops. The differences in total phosphate content of the roots and tops respectively were only significant in two cases, as shown in Table 3.

Fertilizer phosphate uptake showed differences at the 0·05 point only; soil phosphate uptake was significant at the 0·01 level.

The fertilizer phosphate/total phosphate and the fertilizer phosphate/soil phosphate showed no significant differences.

In the tomato experiment, seeds were sown in sterilized John Innes compost. A week later the seedlings were transplanted into 120 6-in. pots, one seedling per pot, and four days later, when they had become established, were treated with the supplementary nutrient solution and the radioactive orthophosphate in 50 ml. respectively. There were six replicates for each treatment. Harvesting was made at six and nine weeks after addition of the tracer. At the first harvest there was a significant increase (at the 1 per cent level) in the soil phosphate uptake in the tops at the 500 μC. per pot level only. There were no significant effects in the tops or roots

Table 2

Experiment 1. Effect of Phosphorus-32 Levels on the Ratios $\frac{\text{Fertilizer Phosphate Uptake}}{\text{Total Phosphate}}$ and $\frac{\text{Fertilizer Phosphate Uptake}}{\text{Soil Phosphate Uptake}}$

P^{32} as μC. per pot	400	150	25	5	1	L.S.D.
$\log_e \frac{\text{Fert. P uptake}}{\text{Total P}} \times 10$	1·159*	1·223	1·245	1·205	1·208	0·01 = 0·0414
$\log_e \frac{\text{Fert. P uptake}}{\text{Soil P uptake}} \times 10$	2·063*	2·181	2·228	2·096	2·167	0·01 = 0·0956

Interaction between phosphorus-31 and -32 was not significant

Table 3. Experiment 2. Total Phosphate Content of Barley Roots and Tops at Varying Levels of Phosphorus-32

P^{32} μC./pot	500	25	4	0·5	0	L.S.D.
Total P (mgm.) roots (mean of 8 plots)	2·165	2·118	1·795	1·896	1·844	0·01 = 0·310
Total P (mgm.) tops (mean of 8 plots)	4·923	4·643	4·065	4·884	5·266	0·01 = 0·778

The interaction between phosphorus-31 and -32 was not significant

for dry weights, total phosphate, fertilizer phosphate uptake, and fertilizer phosphate uptake/soil phosphate uptake ratio. Moreover, at the second sampling there were no significant effects in any of these functions.

These experiments show that radiation effects on the growth and physiology of barley and tomato do occur at low radioactive dosages, lower than those accepted as 'safe' by some investigators. Thus for certain experiments this must be taken into account by adopting a statistical lay-out with two or three levels of phosphorus-32 and -31. The most striking feature of the experiments as a whole, however, is the smallness of the radiation effects, despite the fact that we have worked at concentrations of phosphorus-32 far greater than would normally be used in 'tracer' work, and at much higher specific activities (μC. phosphorus-32 per gm. phosphorus-31) than those adopted by other workers (see Table 4).

We have not made a detailed examination of the morphological and cytological changes which may well have occurred in the root tissues. We have considered only the criteria that would be used in plant nutrition studies in soil with phosphorus-32.

It would thus appear from our investigations that the overall effects of radiation are slight, and are in no way sufficient to preclude the use of phosphorus-32 in plant nutrition experiments in soil. [Sept. 27.

Note added in proof. In a further pot experiment with barley, completed after this article was submitted, no significant effects were observed in any of the functions discussed previously. The soil used was a sandy loam high in organic matter (*p*H 5·0), supplied with one level of sodium orthophosphate equivalent to 500 lb. of superphosphate per acre and with phosphorus-32 at the following rates: 0, 1, 5, 25, 125 and 400 μC. per pot.

Table 4. Phosphorus-32 Levels used in Fertilizer Experiments

Workers	References	Microcuries P^{32} per gm. P^{31}	lb. phosphorus-31 per acre
Hendricks and Dean	*Proc. Soil Sci. Soc. Amer.*, **12**, 98 (1947)	980	—
Dean *et al.*	*Proc. Soil. Sci. Soc. Amer.*, **12**, 107 (1947)	230–1,150	100
Spinks and Barber	*Sci. Agric.*, **27**, 145 (1947)	150–1,000	6·7
Spinks and Barber	*Sci. Agric.*, **28**, 79 (1948)	54	6·7
Dion *et al.*	*Sci. Agric.*, **28**, 309 (1948)	33–1,600	6·7, 20·1 and 60
Dion *et al.*	*Nature*, **163**, 906 (1949)	26–260	5, 10 and 21
Hendricks and Dean	*Trans. Fourth Intern. Cong. Soil Sci.*, **1**, 221 (1950)	229	15
Russell, Martin and Adams	*Trans. Fourth Intern. Cong. Soil Sci.*, **2**, 138 (1950)	12–1,200	9 and 49
Long Ashton	1950	12–29,760	15 and 37

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EAST MALLING RESEARCH STATION

ANNUAL REPORTS FOR 1948 and 1949

THE thirty-sixth annual report, for 1948, of the East Malling Research Station of the Kent Incorporated Society for Promoting Experiments in Horticulture* includes an appreciation by T. N. Hoblyn of the retiring director, Sir Ronald Hatton. Sir Ronald made a fundamental contribution to the science of fruit-growing by classifying the wilder stocks upon which the gentler scions of commercial fruit varieties are grafted. This, more than any other single investigation, has made possible the development of modern standardized commercial fruit-growing. Sir Ronald was not the Station's first director, but was responsible for its period of most active development. He has been succeeded by Dr. F. R. Tubbs.

The report includes the usual sections describing the experimental farm, reviewing the research work, and a new section of bulletins for fruit-growers. Fifteen research papers form the main part. H. M. Tydeman describes two new varieties. Tydeman's Late Orange is an apple somewhat more vigorous and later than Cox's Orange Pippin, which is one of its parents. To judge by the coloured frontispiece, the variety is indeed attractive. Amos Black is a promising variety of blackcurrant, heavy yielding, late in flowering to escape spring frosts, and firm in the skin to travel without damage. Mr. Tydeman also reports on fifteen quince stocks for pears. They are all, in general, less vigorous than Malling *A*, *B* and *C*, and, though trees from the more dwarfing stocks were more productive for their size, the total yield of fruit was less than when the more vigorous *A*, *B* and *C* stocks were used. A. P. Preston shows that bees often have difficulty in reaching the nectary of Bramley's Seedling apple flowers because of the close bunch of stamens. This is a character which might be avoided when breeding new varieties of apple. The same author also describes the production of a primary branch framework on apple trees. Notching above a bud to ensure its development into a branch leader is a successful practice to this end.

R. J. Garner and E. S. J. Hatcher describe a large-scale experiment on the relation between water-table and vegetative propagation. An interesting incidental result is the discovery of fructifications of the fungus *Stereum purpureum* on cuttings of marianna plum

* East Malling Research Station. Annual Report, 1948. Pp. 162 + 20 plates. 10s. Supplementary Annual Report, General Development and Activities, 1948. Pp. 30. (East Malling: East Malling Research Station, 1949.)

one year after planting. Circumstantial evidence strongly suggests that the cuttings were invaded by the fungus while still alive. M. C. Vyvyan, C. West and H. W. B. Barlow found that a fortnight's delay in picking greatly improved the quality of Cox's Orange Pippin apples after three months in store. The delay, however, resulted in a heavy drop of fruit which could, nevertheless, be controlled by spraying with alpha-naphthalene-acetic acid (10 p.p.m.) about a month before picking. This had no effect upon the quality of the fruits. Hardwood cuttings of the plum rootstock Myrobalan *B* were found by E. S. J. Hatcher and R. J. Garner to root best when taken between mid-October and early February. The earlier planting, however, had more vigour of growth.

The grey mould fungus *Botrytis cinerea* probably causes more widespread parasitism than is generally realized. It is now noted by M. H. Moore as the probable cause of cankers and rotting in apple and other hosts. A. M. Massee notes some rather unusual cases of damage by insects; they include *Apion* spp. feeding on apple foliage, cockchafer larvæ on the roots of hops, weevils attacking strawberry roots and earwigs feeding upon fruits of peach. Predators of the fruit tree red spider mite have been studied by Elsie Collyer. One of them, the black-kneed capsid, *Blepharidopterus angulatus*, was of practical importance in Essex. Some workers have found that nitrophenol emulsions are less toxic to insect eggs when alkaline than when acid. R. G. Davies and J. K. Eaton found this to be so, but with 2 : 4-dinitro-6-methylphenol (DNC) and related substances the effect would not be significant in practice between *p*H 4 and 8; it was only seen at *p*H 10.

The thirty-seventh annual report of the Station, for 1949, covers only the first nine months of the year, but is larger than usual*. The research section of the report contains twenty-four papers, including the text of the second Amos Memorial Lecture, "The Soil and the Fruit Tree", by B. S. Furneaux. Preliminary laboratory and field experiments by W. S. Rogers and Irena Modlibowska have shown that continuous sprinkling of fruit tree blossoms with water during spring frosts can protect them from frost damage at air temperatures round about −2·2° C. (28° F.). Sprinkling also cooled the soil by 1–2° C. at 4 in. depth without harmful effect. R. J. Garner condenses, in a short paper, the results of fifteen years of work on framework-grafted Laxton's Superb on thirteen-year-old trees of Newton Wonder. This method of renovating trees gave thicker trunks, more spreading branches and heavier crops than did top grafting. N. H. Grubb describes two new raspberry varieties, Malling Jewel and Malling Exploit. The latter is stated to have superior dessert quality to the other Malling varieties. Hop stems layered prior to propagation by cuttings are shown by Dorothy J. Wilson to develop a large amount of phloem and a store of starch; buds begin to develop when light is excluded.

In the section on statistics, S. C. Pearce and J. Taylor recommend that experimental trees should be 'calibrated' by growth before an experiment is performed with them. 'Strip' and 'tile' lay-outs for this method of assessing individual potentialities are described. Studies of the organic constituents of fruit plants revealed the presence of phloridzin, glyoxal and sorbital in a methyl alcohol extract of apple shoots (J. K. Eaton). Chromatographic examination confirmed the presence of sorbitol and phloridzin, with numerous fractions of carbohydrates, acids and other substances (A. E. Bradfield and A. E. Flood). Methods of analysis provide important contributions to research equipment; F. H. Vanstone and H. J. Philcox describe a method of building materials into a 'Cellophane' tube for flame spectrographic analysis, and A. C. Mason gives full methods for tissue analyses of small samples for seven elements; Anne V. Delap has a new interveinal injection needle.

P. C. R. Webb, studying the canker-producing bacteria, *Pseudomonas mors-prunorum* and *Ps. prunicola*, finds that bud infection of the fruiting spurs of sweet cherry is common, and frequently gives rise to cankers. Viable bacteria were isolated from surfaces which had received 6–9–100 Bordeaux spray three weeks previously. I. W. Prentice reports successful graft transmission of the disease known as rubbery wood of the apple variety Lord Lambourne. He interprets the results as supporting the view that rubbery wood is caused by a virus. A review of insect pests during the year by A. M. Massee includes special reference to the pear sawfly, a new pest of cultivated pears in Great Britain. Full details of the life-history of the strawberry aphis, *Pentatrichopus fragæfolii*, are given by G. H. L. Dicker, with the results of experiments on its control with, *inter alia*, 'Parathion' and *bis* (*bis*-dimethylamino)-phosphonous anhydride. The same author also describes the shallot aphid, *Myzus ascalonicus*, which has caused damage on strawberry, and the control of the apple capsid by spraying early in March with DDT dissolved in tar oil. Catherine A. Blair has investigated the life-history of the fruit tree red spider mite. Control of apple sawfly can be achieved, according to R. G. Davies and J. K. Eaton, by sprays of gamma-benzene hexachloride 'Parathion', and the chlorinated hydrocarbon, 'Chlordane'. These substances give a superior control to that of a petal-fall spray of nicotine.

A useful series of bulletins for fruit-growers is included in the report. These deal with results which are now incorporated into modern practice, or incipiently so; it is in no invidious sense that they are not reviewed here.

* East Malling Research Station. Annual Report, 1st January 1949 to 30th September 1949. Pp. 187+21 plates. (East Malling: East Malling Research Station, 1950.)

SCIENCE MASTERS' ASSOCIATION

JUBILEE MEETING

NEARLY a thousand members of the Science Masters' Association, which comprises the bulk of the teachers of science in the public and grammar schools of Great Britain, together with many from the universities, the modern secondary schools and from schools overseas, met in London during the first week of January for the jubilee meeting of the Association.

Morning lectures were given in the Royal College of Science, and the evening lectures in the Huxley Buildings of the Imperial College of Science and Technology, while the afternoons were devoted to visits to research laboratories, Ministry of Supply institutions and commercial works, or alternatively members had the opportunity of seeing some of the latest teaching films in science. Publishers and manufacturers showed books and apparatus useful in the laboratory, while most valuable of all was the

members' exhibition, in which more than fifty members showed nearly three hundred pieces of apparatus or experiments they had themselves designed or devised and had found useful in class teaching. Chief among this display was that of Mr. F. A. Meier, senior lecturer in science at the Institute of Education in the University of London, whose prolific output of ideas in new teaching devices necessitated his being given the opening session of the meeting in which to explain the wealth of ingenious apparatus he had on show for teachers of physics.

Prof. J. Z. Young, of University College, London, spoke in a crowded lecture theatre of biologists on the brain and its activities with special reference to a study of learning in the octopus. The octopus had been chosen for the study of learning because the nervous system is large, complicated and different from that of the vertebrates. The animal is convenient for experiments and operations. It is possible to show that the learning processes which go on depend upon the integrity of certain lobes. There is indication that the learning depends on the establishment of self-exciting chains of excitation. The similarities and differences between this nervous system and that of vertebrates provide most suggestive material for the discussion of the nature of the higher nervous activities. This lecture was illustrated and was built up around a film, taken by Prof. Young and his colleagues in Naples.

Thanks to the kind offices of the Atomic Energy Research Establishment at Harwell, Dr. Henry Seligman, head of the Radioisotopes Division, was able to lecture about the production and use of radioisotopes, and his assistants to demonstrate their use in agriculture, medicine and industry. The most spectacular demonstration was that of a full-scale model of a 'packeted-goods testing machine', in which cartons passing on an endless belt were detected if inadequately filled, the energy thus passing through the container being used to operate either a warning light or a mechanism for ejecting the faulty packet. Other demonstrations were given of the way in which radioisotopes can be used for detecting the uniformity of mixtures made on the commercial scale; the high degree of accuracy of measurement of the most minute particle and its location were remarkable.

The chemists of the Association were particularly fortunate at this meeting in that there were three lectures devoted to different aspects of chemistry, each amplifying the other. The president of the Association, Sir Robert Robinson, devoted his presidential address to a plea for the earlier introduction of the study of organic chemistry, illustrated by suggestions as to the way the theory should be taught and the matter presented in an up-to-date fashion.

Prof. C. K. Ingold, of University College, London, devoted his lecture to a discussion of the nitronium ion, NO_2^+. Converging lines of approach have been followed, from the physical side, from the spectroscopical side, from the analytical side and from a study of the rates of reaction in organic nitrations, the culminating work of which is only some four months old. The properties of the nitronium ion were discussed, and crystals of some of its few stable salts were displayed. The historical development was well brought out during the lecture, each section being linked up with its fellows both in time and in purpose, while the work of the earlier experimenters was given its due consideration, thus providing a coherent picture of the investigation as a whole and leaving the audience with such a rounded-off picture of the NO_2^+ ion that sixth-form pupils in many schools will have a clear guide through the past work and a directive by means of which future expansions of knowledge can be the more easily understood.

The third lecture of this series was given by Prof. C. A. Coulson, of King's College, London, who dealt with the nature of the chemical bond. By the use of simple wave mechanics it was shown that the pre-1926 ideas of 'discrete' electron particles moving in definite orbits has had to be discarded, to be replaced by a factor dependent upon the probability of expectation of occurrence in definite neighbourhoods. This gives rise to patterns which have replaced the old so-called valency bonds and are termed 'orbitals'. This pattern for an electron around a nucleus in an atom may be symmetrical, or it may have a semblance to a dumb-bell shape should there be two electrons, in which case they must have opposite spin. Whichever pattern is set up, however, a definite amount of energy is associated with it. For molecules, where there will be the linkage between a pair of atoms, there will be not only the atomic orbitals, but also a molecular orbital. This is not merely a summation of the atomic orbitals, but also shows a piling up of energy between the two atomic centres. From this a plan may be drawn linking together points of equal energy, giving a kind of contour map of the molecular area. Molecular linkage is then seen to be the overlapping of orbitals, so that the strongest binding takes place where there is the greatest overlapping. The angle to achieve this state gives the valency angle, and where the overlapping is reduced or diverted there is strain.

In the evenings, two lectures were given. The first was by Mr. A. H. T. Glover, and the second by Dr. W. R. Matthews, dean of St. Paul's.

Mr. Glover, director of educational research to British Pathé Films, Ltd., gave his lecture under terms of the Science and Citizenship Trust. Mr. Glover analysed the conditions of modern life and the interplay of forces impinging upon the individual and upon society, and from this devised a graphical scheme as a basis for the instruction of the 90 per cent of the school population of Great Britain which is not going to become the intelligentsia of the future. From this he indicated the part science and teachers of science have to play in the development of the citizen and in the investigation of the problems set forth.

Dr. Matthews analysed the differences between the scientific acquisition of knowledge, and religious experience resulting in knowing, and showed that, whereas scientific thought tends to predominate in concepts, religion must use images and myth as the only way to convey its ideas. So far from there being a resolution of the erstwhile conflict between science and religion, as so many affirm, there can never be, in the nature of the case, a cessation of the tension between them. Hence, each must respect the other.

On the social side, the Association was honoured by an invitation to attend a reception at the Mansion House, where the members were received by the Lord Mayor, Alderman Denys Lowson. The commemorative dinner, at which about five hundred were present, was the chief event of the jubilee. The principal guest was Mr. D. R. Hardman, Parliamentary Secretary to the Ministry of Education, who conveyed to the Association the appreciation of the

Minister for all it has done for the teaching of science. Many learned societies and kindred bodies were represented at the dinner, as were also teachers of science from abroad.

For the afternoon visits, several hitherto unopened doors admitted members of the Association to see the applications of science to many branches of human activity. Through the courtesy of the trustees of the British Museum, the Research Laboratory showed how antiquities are recovered, restored and reproduced. Scotland Yard showed conclusively that crime does not pay and has little chance of being undetected, while the demonstration of the evidence used in some recent cases were most convincing and spectacular.

Almost a thousand members thronged the Royal College of Science daily to see the exhibitions and to attend the lectures, so that a wealth of new knowledge has now gone back to the schools to bear fruit in the more highly stimulating teaching which will be given in the public, grammar and modern schools of Great Britain.

William G. Rhodes

AMERICAN PHILOSOPHICAL SOCIETY

THE year book for 1949 of the American Philosophical Society* includes, besides the reports of standing committees, list of members and auditor's report, several biographical memoirs, among which may be noted those on Dr. J. R. Angell, Dr. J. Hjort and Dr. F. B. Jewett. The library committee reports considerable progress in acquisitions, particularly in political and scientific pamphlets of the eighteenth century, in special collections of manuscripts and in the Indian collection and archæology. The interlibrary loan service again increased, as did the work of the microfilm laboratory. The report from the committee on publications records that, with the exception of a few libraries from which no reply was received, back publications were shipped to all libraries on the foreign exchange list. A list of publications during the year is included. The report of the committee on research sets forth the principles adopted in making grants, and lists the ninety-five grants, totalling 76,596 dollars, awarded during 1949 from the Penrose Fund. Seven grants, totalling 22,000 dollars, were made from the Johnson Fund and one of 5,000 dollars from the Daland Fund.

Among the reports from recipients of grants, that from W. J. Luyten records satisfactory progress in the measurements of the proper motions of stars in the southern hemisphere, north of declination −40°. H. H. Nininger's study of the oxidation products around Barringer crater has led him to offer a satisfactory explanation of the origin of metal-centre pellets and oxide droplets, and investigations of the structure and composition of Canyon Diablo meteorites strongly indicate that the outlying deposits have had a different origin from those which lie on or near the crater rim. V. F. Hess reports two new methods of determining the absolute intensity of cosmic rays in the atmosphere and the residual ionization in ionization chambers. Studies on snow melt are reported by J. E. Church, and the preparation and reactions of oxygen fluoride are described by L. R. Brantley.

In the geological and biological sciences H. N. Andrews, jun., reports on studies of American coal balls in which a new species of *Botryopteris* has thrown light on the evolution of the frond. H. S. Cotton has studied a lake deposit in the Bradshaw mountains of central Arizona containing remains of Miocene or early Pliocene mammals. D. P. Costello's studies on the incidence of heteroploidy in salamander larvæ and on the effects of low temperature on maturation and cleavage in fertilized eggs of *Chætopterus* have involved four main lines of inquiry. One has indicated that *Triturus rivularis* is not well adapted to cytological studies by the methods used, and papers on two other lines of study are in preparation. J. F. Crow's study of the susceptibility to ether of *Drosophila virilis* and its near relatives, *D. americana* and *D. texana*, suggest that resistance is an expression of a general level of vigour which is high in the parents but is less in hybrid combinations because the mutually adapted chromosome sets of the parents are broken up in the recombinants.

Field studies of the genus *Sedum* in the Sierra Madre Oriental of eastern Mexico are reported by R. T. Clausen and have led to the main conclusion that the most closely related species do not occur at the same localities but in adjacent or remote regions. H. J. Dittmer reports on mycorrhizal relationships of subterranean plant parts with soil fungi, and J. Ewan on field studies on Rocky Mountain vegetation, while further ecological studies on stratification of the Arthropoda have been carried out by W. W. Dowdy. G. B. Heiser, jun., reports his studies on biosystematics of the annual sunflowers of eastern Texas and on chromosome numbers in the perennial sunflowers; and M. J. D. White is studying cytological material of various species of the grasshopper genera, *Trimerotropis*, *Circotetix* and *Aerochareutes*, collected in 1949 in west Texas, New Mexico, Arizona, Nevada, Oregon, Idaho, Montana, Wyoming and Colorado. W. Köhler reports on an investigation of direct currents which spread in the visual cortex under conditions of pattern vision, and J. L. Irvin and Elinor M. Irvin on a study of the interaction of 4-aminoquinolines and 9-aminoacridines with nucleoproteins. The antimalarial compounds quinacrine, 7-chloro-4-(1′-methyl-4′-diethylaminobutylamino) quinoline, and 6-chloro-9-(1′-methyl-8′-diethylaminooctylamino)-2-methoxyacridine interact with the nucleoprotein more strongly than with a less highly polymerized preparation of pentosenucleic acid from yeast, but the side chains of the last compound and of quinacrine do not appear to be essential for the interaction.

Among numerous researches in the field of the humanities on which reports have been received may be mentioned those of E. N. Harvey on the history of luminescence; I. B. Cohen's investigation of the work of Benjamin Franklin in relation to the development of physics and general scientific thinking and to the development of science in America; L. S. Cressman's field study of the archæology of the Klamath Indian culture of Oregon and its position in the northern Great Basin culture; H. O'Neill Hencken's investigation of the prehistoric archæology of the Tipasa area in Algeria; the work of H. L. Movius, jun., on Upper Palæolithic material in France; and W. A. Ritchie's archæological investigations in search of the earlier stages of the Curasco culture in southern Ontario.

* American Philosophical Society. Year Book 1949, January 1, 1949–December 31, 1949. Pp. 467. (Philadelphia: American Philosophical Society, 1950.)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Electrocardiogram of the Crocodilian Heart

As part of an investigation of the histology and functional anatomy of the crocodilian heart, electrocardiograms of the heart in intact animals (Nile crocodiles) were recorded. Part of a tracing, using the standard lead, throat to abdomen, is shown in Fig. 1. While the general form of the electrocardiogram is similar to that of the normal human heart (Fig. 2), except that the *T*-wave is inverted in the crocodile owing to the lead used, significant differences are observed, particularly with reference to the spacing of the several events within the cardiac cycle.

Thus, in the crocodile, the time taken for the wave of negativity to pass from the beginning of the *P*-wave (the onset of atrial systole) to the summit of the *T*-wave (the completion of ventricular systole) is about three-quarters of the entire cardiac cycle (from one *P*-wave to the next), whereas in the human this ratio is reduced to one-half. The heart-rates of the crocodile and human are, of course, different; namely, in these cases, crocodile, 36 beats a minute; human, 72 a minute. In a human heart from a case of sinus bradycardia (Fig. 3), in which the rate (37 beats per min.) happened to be practically the same as that of the heart of the crocodile, it will be noted that the *PQRST* complex occupies about the same time as that in the normal human; this signifies that the wave of negativity passes over the heart as quickly as in the normal human rhythm and that the slowness of the heart in the case of sinus bradycardia is due to the lengthening of the 'silent' period, *T* to *P*, while the ratio of the *P*–*T* interval to the entire cardiac cycle becomes reduced still further to three-tenths.

Measurements show that the actual time taken for the wave to pass over the ventricles (that is, the *Q*–*T* interval) in the human in both instances is 0·37 sec., whereas in the crocodile it is 1·0 sec. This difference is still further emphasized when it is remembered that the distance which the wave has to travel across the crocodilian ventricles (the heart of the crocodile in question being about the size of that of the average cat) is very much less than the distance across the human ventricles. The ratio for the above parts of the curves (1·0 to 0·37) is just about the same as the ratio of the *P*–*R* intervals, that is, for the part of the curve related to the passage of the wave across the atria, which takes 0·40 sec. in the crocodile and 0·15 sec. in the human.

Fig. 1

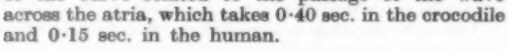

Fig. 2

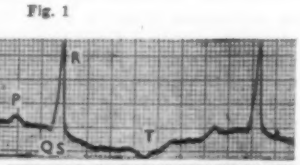

Fig. 3

The crocodilian heart has complete atrial and ventricular septa; but, as our histological investigation has revealed, it possesses no trace of specialized nodal or Purkinje tissues such as are found in the human heart. Thus in the crocodile the impulse for cardiac contraction is initiated and conducted by ordinary cardiac muscle, and the conduction takes very much longer in absolute time and occupies a much greater proportion of the complete cardiac cycle than when Purkinje tissue is provided for its transmission. We submit that in the above phenomena we have further corroboration of the thesis put forward by Davies and Francis[1] that these specialized muscular systems (nodal and Purkinje tissue), found in the hearts of both birds and mammals, are neomorphic structures evolved in conjunction with the higher heart-rates of these homoiothermic vertebrates.

A detailed account of the histology of the hearts of the crocodile and alligator will be published elsewhere.

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Reversible Poisoning of Nerve Fibres by Heavy-Metal Ions

The activity of enzymes is modified—inhibited in most cases—by heavy-metal ions. Blockage of free sulphhydryl groups of the enzyme protein is held to be the cause of the inhibition[1]. A release of these groups, with subsequent recovery of enzyme activity, can be obtained *in vitro* by thiolic substances such as cystein or glutathione, which combine with the metallic ions. The sulphhydryl groups may be blocked also when the enzyme is in its original locus inside living cells. The inhibition of the enzyme is accompanied in this case by a breakdown of various cellular functions. This biochemical lesion (Peters), produced by a number of "substances thioloprives" (Bacq), can be prevented in many instances by mono- and di-thiols; but only in some cases, particularly in poisoning of the whole organism, can it be reversed.

The effect of heavy-metal ions on peripheral nerve has been already studied[2,3]. Their action (block of excitability and impulse conduction) is described as irreversible; attempts to restore nerve function by washing with Ringer's fluid were not successful.

A series of experiments has been performed in order to investigate the influence of thiolic substances on nerve fibres poisoned with heavy-metal ions. Bundles of motor nerve fibres isolated from the sciatic nerve of *R. temporaria* have been employed. They were free from connective tissue, peri- and endo-neural, and were still attached to the gastrocnemius muscle. Excitability threshold (rheobase) was measured every twenty seconds throughout the experiments. No attempt has yet been made to correlate the observed changes of excitability with variations in other nerve properties. Bufferless Ringer's solution was used. The results so far obtained can be summarized as follows.

Salts of cadmium, copper, mercury, silver and uranium produce an inhibition of nerve excitability. Zinc ions failed to cause any change.

The inhibition of excitability is noticeable within a period varying from a few seconds (less than twenty) to two minutes, depending on concentration, after the immersion of the nerve bundle in the solutions. The following were the minimum concentrations necessary for total inhibition: cadmium chloride, 0·01 *M*; copper sulphate, 0·0001 *M*; mercuric chloride, 0·00025 *M*; silver nitrate, 0·00001 *M*; $UO_2(NO_3)_2$, 0·001 *M*.

If the nerve bundles are washed with normal Ringer's fluid within approximately one minute of the onset of blockage, a recovery of excitability can be observed with cadmium and copper, but not with the other metals.

If, when the blockage has been definitely established, the nerve fibres are treated with a 0·001 *M* solution of either cystein or glutathione, an almost instantaneous recovery of excitability is observed. The nerve is at once able both to give rise to and transmit impulses. This recovery, however, has varying characteristics with the different metals. In the case of copper, for example, recovery is only possible if the thiol solution is applied to the bundle within a period of about ten minutes after the onset of the inhibition.

After the excitability reappears on treatment with a thiol, the threshold may be lower than the original value; this is a nearly constant feature of experiments with cadmium and silver. This over-recovery seems to be the more pronounced, within certain limits, the longer the nerve has been blocked.

Some experiments performed with 2 : 3-dimercaptopropanol (BAL) deserve separate description. Three main effects of BAL have been demonstrated: (1) BAL by itself (100 mgm. per cent) causes a slow, but irreversible, loss of excitability. It might be that this action bears a relation to the inhibitory action of BAL on many metal-enzymes[4,5], some of which may play a part in the metabolic processes underlying excitability. (2) A nerve bundle which has been treated with BAL (20–100 mgm. per cent) for a short time (2–3 min.) exhibits high resistance to the action of silver ions; the onset of the block is delayed, and on occasion, with the higher concentrations of BAL, such block does not appear at all. (3) Nerve fibres poisoned with silver ions regain their excitability within a few seconds if treated with BAL (20 mgm. per cent). The drop of the threshold below the original values is very marked in the case of reversal with BAL.

Two conclusions can be drawn, in our opinion, from the foregoing results. (*a*) There is no direct proof of the participation of sulphhydryl groups in the blockage of nerve excitability by metallic ions. However, confronting these experiments with the evidence derived from biochemical investigation, it seems probable that some functional condition of nerve, representing an essential basis for excitability, depends directly upon the presence of free sulphhydryl groups in nerve proteins. (*b*) The very short time required both for the inhibition and the recovery of excitability makes it improbable that diffusion processes through the fibre membrane play an important part in such phenomena. The metal-complexing groups responsible for excitability changes might be located in the surface of the fibre, being, perhaps, analogous to the uranium-complexing groups responsible for glucose metabolism which, as Rothstein and co-workers have shown[6], are present in the surface of yeast cells.

As Lorente de Nò[7] has recently pointed out, it is probable that dissection procedures as used in the present investigation result in a modification of the properties of nerve fibres. This could certainly explain the striking difference between the times required for blocking excitation in isolated nerve fibres and intact nerves by the same concentration of metal ions. It is difficult, however, to see how such a deterioration of the fibres should still allow the prompt and complete reversal of the block by thiol solutions, or even by washing with normal Ringer's fluid as in the case of copper and cadmium, something which cannot be shown in the intact nerve.

A fuller account of these experiments will be published elsewhere.

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Sept. 21.

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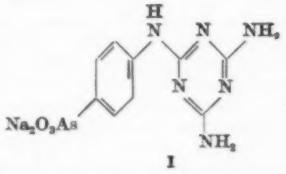
Acquired Resistance to 'Melarsen', Tryparsamide and Amidines in Pathogenic Trypanosomes after Treatment with 'Melarsen' Alone

'MELARSEN' (disodium - *p* - melaminylphenylarsonate[1], I) is active against tryparsamide-resistant trypanosome strains both in the field[2] and in the laboratory[3], and is more effective than tryparsamide (sodium *p*-glycineamidophenylarsonate) in rendering trypanocidal the cerebrospinal fluid in rabbits[4]. In view of these properties, the behaviour of a 'Melarsen'-resistant trypanosome strain seemed to merit investigation.



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Three-quarters-grown male white mice weighing 16–26 gm., infected with a strain of *Trypanosoma rhodesiense* (maintained by serial syringe passage in mice in the Liverpool School of Tropical Medicine since 1924), were treated intraperitoneally with the minimum effective dose of 'Melarsen', namely, 0·6 mgm. per 20 gm. body-weight. The drug was given 48 hr. after intraperitoneal injection of approximately 2×10^4 parasites, when microscopic examination (1/6 obj., 4 × oc.) of a drop of tail blood showed 1–10 parasites per field. The minimum effective dose is defined as the dose which, administered at this time, causes temporary disappearance

Effect of Diamidine and Diguanidine Trypanocides on the Parent and 'Melarsen'-resistant Strains of *T. rhodesiense* in Mice

Compound	Trypanosome strain	Dose (intraperitoneal) MED*	CD_{50}†	MTD**	Resistance
'Melarsen'	Parent	15 15*R*	—	15 15*C*	
	Resistant	10 10*N*	—	38 38*N*	+
Decane diamidine	Parent	—	—	5 5*R*	
	Resistant	—	—	5 5*N*	+
'Synthalin B'	Parent	—	—	9 7*R* 2*N*	
	Resistant	—	—	10 10*N*	+
'Stilbamidine'	Parent	—	13 8*C* 5*R*	10 6*C* 4*R*††	
	Resistant	—	15 15*N*	9 6*C* 2*R* 1*N*	±
'Pentamidine'	Parent	15 1*C* 13*R* 1*N*	8 3*C* 5*R*	8 3*C* 5*R*††	
	Resistant	15 15*N*	5 5*N*	10 10*N*	+

* Minimum effective dose; † median curative dose; ** maximum tolerated dose.

Results shown as follows:
4 1*C* 1*R* 2*N* = 4 mice treated; 1 cured (blood cleared of trypanosomes for at least 28 days), 1 relapsed (blood temporarily cleared), and 2 not affected (blood not cleared).
\+ = Fully resistant; ± = resistant to CD_{50} but not to maximum tolerated dose.
†† These mice died with parasite-free blood, but before the minimum survival-time taken as the criterion of cure (28 days).

of parasites from the peripheral blood, for at least 24 hr. after treatment.

Passage of the relapse strain was followed by further treatment, and repetition of this procedure, with increasing dosage, produced in eighteen weeks and thirty passages a strain which was completely resistant to the maximum tolerated dose of 'Melarsen', namely, 6·8 mgm. per 20 gm. body-weight. This represents more than an eleven-fold increase of resistance.

In cross-resistance tests (Ehrlich's *cribrum therapeuticum*), the 'Melarsen'-resistant strain was found to be completely resistant also to the maximum tolerated dose (intraperitoneal) of the following trypanocidal substances: (i) *n*-decane 1 : 10 diamidine dihydrochloride; (ii) 'Synthalin *B*' (*n*-dodecane 1 : 12 diguanidine dihydrochloride); (iii) 'Pentamidine' (4′ : 4″-diamidino-diphenoxy-1 : 5-*n*-pentane diisethionate); (iv) 'Melarsen oxide' (*p*-melaminylphenylarsenoxide); (v) 'Tryparsamide'; (vi) 'Mapharside' (*m*-amino-*p*-hydroxyphenylarsenoxide); (vii) acriflavine (a mixture of 2 : 8-diaminoacridine dihydrochloride and 2 : 8-diaminoacridinium methochloride); (viii) proflavine (2 : 8-diaminoacridine sulphate); and (ix) parafuchsin (triamino-triphenylmethane hydrochloride).

Partial resistance (that is, to the median curative dose but not to the maximum tolerated dose) was shown to the aromatic diamidine 'Stilbamidine' (*trans*-4 : 4′-diamidinostilbene dihydrochloride) (see table). No resistance whatever was shown to 'Suramin' (= 'Germanin' = 'Bayer 205' = 'Antrypol') (3 : 3′-ureido-*bis* [8-(3-benzamido-*p*-toluido)-1 : 2 : 5-naphthalene sulphonic acid]), or to 'Butarsen' (sodium γ-(*p*-arsenosophenyl)butyrate), which is active against other strains of *T. rhodesiense* resistant to non-acid-substituted aromatic compounds of arsenic[5,6].

Earlier evidence[7] showed that a strain of *T. rhodesiense* resistant to undecane diamidine and to synthalin was normally sensitive to non-acid-substituted phenyl arsonates and arsenoxides, and conversely, that a strain of *T. rhodesiense* resistant to the latter group of substances was normally sensitive to trypanocidal diamidine and diguanidine compounds. On this basis, the sites of action of the two groups of drugs were assumed to be separate.

A strain of *T. rhodesiense* resistant to non-acid-substituted phenyl arsonates and arsenoxides, and to trypanocidal acridines (tryparsamide–mapharside–acriflavine type-group), is normally sensitive to melaminyl-substituted phenyl arsonates and arsenoxides[3], but the present observations show that the converse is not true. Since resistance to arsenical trypanocides is probably associated with alteration of selective cell permeability, it may be that, as suggested earlier[3], 'Melarsen' shares with tryparsamide-type trypanocides the same ultimate lethal action (inactivation of metabolic sulphydryl groups) but differs in its fixation on, or route of entry into, the trypanosome cell. 'Melarsen'-resistant trypanosomes may thus have lost selective permeability to, or preliminary adsorption affinity for, both the melaminylphenyl structure and the tryparsamide–mapharside–acriflavine type-group structure, whereas tryparsamide–mapharside–acriflavine type-group-resistant trypanosomes would seem to be impermeable to, or non-adsorptive for, the relevant tryparsamide–mapharside–acriflavine type-group structure only.

The melamine moiety possesses, in common with the diamidine and diguanidine trypanocides, at least two functional units of the amidine type, $=N-\overset{|}{C}=N-$; and loss of permeability to, or adsorption affinity for, the melamine grouping in the 'Melarsen'-resistant strain may possibly prevent initial uptake of the amidine-type drugs, irrespective of the ultimate site of action of the latter. Molecular planarity has been stressed as an important factor in drug action[8]; the amidine-type structural unit probably provides a common factor of molecular planarity for 'Melarsen' on one hand, and for 'Stilbamidine' (molecule wholly planar), 'Pentamidine' (planar amidinophenyl moieties), decane diamidine (planar amidine groups), and 'Synthalin B' (planar guanidine groups), on the other.

A more extended account of these observations will be published elsewhere.

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Respiratory Metabolism of Parasitic Helminths without Participation of the Cytochrome System

Laser[1] has demonstrated high succinic dehydrogenase activity in extracts of muscle pulp of *Ascaris lumbricoides*. In the presence of succinate these preparations reduce methylene blue, but do not react with atmospheric oxygen. On the other hand, succinate stimulates the respiration of dialysed muscle mince of *Ascaris*[2]. Furthermore, we have observed that homogenates of thoroughly washed *Ascaris* muscle oxidize succinate even in the absence of methylene blue. The activity of this preparation was markedly higher in 100 per cent oxygen than in air, and was increased when catalase and ethyl alcohol were added, indicating the production of hydrogen peroxide[1]. No oxygen uptake was observed under similar conditions in the absence of succinate. Therefore, succinic dehydrogenase of *Ascaris* muscle can transfer hydrogen either to methylene blue or to an enzyme system, which, in turn, reacts with atmospheric oxygen. However, the latter is not identical with the cytochrome–cytochrome oxidase system considered to be the universal catalyst of all respiring cells[3].

Addition of homogenates of unwashed *Ascaris* muscle did not increase the oxidation of succinate by succinoxidase of pig heart prepared according to Keilin and Hartree[4]. This preparation is deficient in cytochrome *c*, and as little as 3×10^{-10} moles of cytochrome *c* can be determined manometrically by this assay (v_F, 1·0 ml.; v_G, 4–5 ml.; *p*H 7·4). The activity of pig heart succinoxidase in the presence of succinate and of low concentrations of cytochrome *c* (6×10^{-7} molar) was not inhibited by the same homogenate of *Ascaris* muscle. On the basis of this assay, *Ascaris* muscle contains less than 2×10^{-9} moles of cytochrome *c* per gm. Furthermore, no cytochrome oxidase activity could be detected in *Ascaris* muscle homogenates when they were added to cytochrome *c* (molar concentration: $3{\cdot}8 \times 10^{-5}$) and hydroquinone (molar concentration: $3{\cdot}6 \times 10^{-3}$) (15° C.; *p*H 7·1). By contrast, cytochrome oxidase activity was observed when homogenates of rat lung were used. The latter contained five times less tissue than the *Ascaris* homogenates. Among mammalian tissues, lung has the lowest cytochrome oxidase activity[5]. The absence of cytochrome oxidase activity was not due to an inhibitory effect of this tissue on the enzyme, because the activities of cytochrome oxidase preparations[4,6] were the same in the presence or in the absence of *Ascaris* muscle homogenates.

While succinate oxidation by washed *Ascaris* muscle preparations was increased by methylene blue (but not by two metalloporphyrin pigments recently isolated from *Ascaris* by Davenport[7]), no effect was observed with either cytochrome *c* or a cytochrome oxidase preparation containing no succinic dehydrogenase[6], added alone or together. Therefore, succinic dehydrogenase of *Ascaris* does not react with the cytochrome system, the presence of which we were unable to detect in this organism. Possibly a flavine enzyme participates in the oxidation of succinate by *Ascaris* muscle.

Evidence has been obtained that the cytochrome system is not involved in the respiration of two other parasitic worms, the filarial nematode *Litomosoides carinii* and the trematode *Schistosoma mansoni*. The oxygen uptake of these two helminths is inhibited completely by cyanide (molar concentration: 2×10^{-4})[8]. Yet, assay procedures similar to those used for *Ascaris* muscle revealed no cytochrome *c* nor cytochrome oxidase activities in the filariæ. The schistosomes contained measurable cytochrome and cytochrome oxidase activities; but they accounted for less than 10 per cent of the overall oxygen consumption of these worms.

It is concluded that respiration in the above three helminths is mediated predominantly, if not exclusively, by respiratory catalysts which are not identical with the cytochrome system.

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Influence of Folic Acid on Xanthine Oxidation *in vitro*

An inverse relationship between liver xanthine oxidase and dietary folic acid has been demonstrated in the chick[1,2]. Similar effects are reported for D-amino-acid oxidase activity[2,3] and in glycine metabolism[4]. Since hydrogen peroxide, a product resulting from oxidations involving flavo-protein enzymes, is known to bring about destruction of hæmoglobin[5], these observations have been interpreted to mean that an excessively rapid rate of such oxidations may contribute to the breakdown of hæmoglobin or hæm-containing enzymes *in vivo* and thus explain a biochemical change in folic acid deficiency[1]. However, recent reports would suggest that folic acid may not have a direct influence on catalase activity[3] or on liver xanthine oxidase in the rat[6]. Furthermore, earlier observations on the *in vitro* inhibition by folic acid of xanthopterin oxidase activity have now been ascribed to an aldehyde impurity which is a primary photo-fission product of the vitamin[7].

The influence of folic acid on xanthine oxidation seemed therefore to merit re-investigation. Working with systems containing a milk xanthine oxidase preparation and catalase[8], we have observed in various experiments some 10–40 per cent stimulation of xanthine oxidation *in vitro* in presence of aldehyde-free folic acid in concentrations of 60–300 mμgm. per cent, which correspond more nearly to the levels obtaining in normal plasma and liver than those used by previous workers. Folic acid does not exert any activation in absence of catalase, the influence of which was shown to be enzymic from experiments with heated catalase. In amounts of 1·5 gm. and more, folic acid inhibits xanthine oxidase activity by at least 20 per cent, presumably by competition with

the substrate for the active catalytic surface of the enzyme (cf. ref. 9).

These conclusions were reached independently by following xanthine oxidase activity manometrically[8] and from determinations of residual xanthine[10]; in the latter case, there was interference, as yet not fully examined, due to the other additions present along with the xanthine; but, on a comparative basis, the results were confirmatory of those on direct measurements of oxygen uptake. There was no evidence of an endogenous oxygen uptake initially in the system containing folic acid and xanthine oxidase (cf. ref. 9).

Attempts to demonstrate a direct effect of folic acid on catalase activity[2] were not always successful; evidently, therefore, this occurred only where the release of hydrogen peroxide was gradual and steady, as in the systems with adenine–flavine–dinucleotide enzymes.

The functional significance in xanthine oxidation of naturally-occurring forms of folic acid in yeast fractions or in enriched bacterial cells, and of the *L. citrovorum* factor, which has been reported to be a form of folic acid highly active physiologically[11], are being investigated.

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Control by Light of Reproduction in Ferrets and Mink

It has long been known that additional light after dark will accelerate the breeding season of the ferret[1]. Like the ferret, the mink breeds in spring; but it differs in that its season is earlier and much shorter, and by the occurrence of delayed implantation for a period increasing with earliness of mating[2]. Artificial extension of day-length has been shown to shorten gestation[2,3]. Hansson[3] has attempted to advance the start of the mink season by ultra-violet irradiation at dawn and dusk; he produced some increase of ovary and uterus weights, but did not hasten mating activity.

That the light regulates pituitary activity may be presumed; but the manner of action is by no means certain. Wave-length, intensity and daily duration of light exposure, and day-to-day change and rate of change of these, are all possible factors. In the following experiments the animals were kept entirely in artificial light; only the duration of exposure was varied.

(1) Mink and ferrets were put in winter on treatments including: (*a*) regularly increasing illumination, and (*b*) constant (7 hr.) light, broken by a constant (5 hr.) dark period, daily. (Hart[4] had found 1 hr. light at midnight an effective stimulus for ferrets in midwinter.)

Ferrets on (*b*) became œstrous after a latent period of some weeks, and ahead of those on treatment (*a*). The most striking result with the mink—returned to daylight at the end of February—was that at the height of the natural season (mid-March) the females had all anœstrous vaginal smears, the males all testes shrunken as in midsummer. The vaginal smears of mink during treatment went in general through an œstrous phase, and started ahead of the ferrets. A point of present interest is that some on treatment (*b*) had no œstrus—at least not before the end of the normal season—though in others the season was accelerated (or possibly only curtailed).

(2) In the summer, mink were at intervals taken from daylight and put on to a (constant) short day. Except for a few which remained on short days, they were then put on to an increasing day-length. They began to moult, and to come into their winter coats (this has been reported previously[5]); also their vaginal smears became œstrous. The times of these changes were related to the times the animals were put on short day, not to the time of increasing day-length. Further, the smears of controls kept on short day became œstrous.

Like the moulting, the œstrous smear appeared as a delayed response to short days. It is of interest that the two processes, in Nature separated by weeks, were telescoped together—which might imply they have different day-length thresholds.

Confirmation that the spring breeding season of mink is (in part—for implantation seems to be a 'long-day' phenomenon) a 'short-day' response is found in the circumstances, (i) that spermatogenesis may start in December[6], and (ii) that some females, on normal daylight, were found to have œstrous smears in early January.

(3) Ferrets were placed in January on constant 14-hr. or 24-hr. light daily. The group in 14-hr. light became œstrous sooner than those in 24-hr. light (which, indeed, were little ahead of what would have been expected in daylight). An action of darkness, as well as of light, in accelerating œstrus is thus suggested. The result is similar to one of Hart's[4] (the interpretation of which was complicated, owing to the use of daylight as part of the light source).

One may recall two reports made in the early days of Bissonnette's[1] original discovery: first, the observation that size of testis in the ferret begins to increase in December[7]; secondly, Hill and Parkes's[8] experiment in which ferrets kept from the end of January almost completely in the dark yet came on heat with little, if any, delay.

Experiments 1 and 2 were carried out at the Worcester Foundation for Experimental Biology, Shrewsbury, Mass., and were supported by a grant from B. H. Weiss, Inc. Experiment 3 was done with animals and facilities made available by the

Animal Research Station, Cambridge. Detailed accounts of these experiments will appear elsewhere.

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Circulating Antibodies in Rats resistant to *Nippostrongylus muris*

Sarles and Taliaferro[1] presented evidence that the acquired immunity of rats to infestation with *Nippostrongylus muris* could be transferred passively and was manifested by increased local reactions to migrating worms in the skin, lungs and intestine. These studies were extended by Chandler[2] and Sarles[3,4].

In a recent study of the resistance of sheep to infestation with *Hæmonchus contortus* and *Trichostrongylus* spp., circulating antibodies were detected by means of the complement-fixation test with an antigen prepared from the parasites or their larvæ[5–7]. Similar tests have since been carried out on rats infested with *N. muris*.

It was found that an antigen prepared from adult *N. muris* reacted with sheep sera which gave a positive reaction to *H. contortus* antigen. Tests of sera from rats suffering their initial infestation, or from rats in which the initial infestation had declined, were uniformly negative in complement-fixation tests with antigens prepared either from adult *N. muris* or from infective larvæ of *H. contortus*. However, when eight rats which had thrown off an initial infestation were given a further subcutaneous dose of *N. muris* larvæ, six developed serum titres of between 1/20 and 1/80, ten days later.

In another experiment, seven rats were each given three subcutaneous doses of 2,000 *N. muris* larvæ at intervals of one week. After a lapse of two weeks they received a challenge dose of 5,000 larvæ each, and, at the same time, a control group of eight rats received an initial dose of 5,000 larvæ each. Both groups were slaughtered a week later. All the control rats had developed infestations of at least 1,000 worms, and their sera were frankly negative to the complement-fixation test. Four of the rats which had received multiple doses of larvæ were free from infestation with *N. muris* and had developed serum titres between 1/40 and 1/80. The serum of one rat was positive at a dilution of 1/10, and the remaining two sera gave slight reactions at 1/10. These three rats were infested with between 50 and 100 worms each.

From these experiments, it would appear that rats resistant to re-infestation with *N. muris* develop circulating antibodies.

I am indebted to my colleague, Dr. W. P. Rogers, for arranging for the infestation of the rats. The work described formed part of the programme of the Division of Animal Health and Production, Commonwealth Scientific and Industrial Research Organization.

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Fate of *Cimex lectularius* on Adult and on Baby Mice

PREVIOUS reports on an investigation of the relationship between ectoparasite and host[1] have shown that the economy of an ectoparasite can be adversely affected by various changes brought about in the host. So far, these changes have been induced by artificial means. We owe to Buxton[2] the precise demonstration that, even in Nature, all individuals of the same species are not equally good hosts. Buxton showed that when fleas (*Xenopsylla cheopis*) are reared on baby mice the females begin to oviposit after a considerable delay and produce less eggs than on an adult mouse. In these experiments the baby mice were separated from the mothers for 24-hr. periods.

We report here experiments on these lines with *Cimex lectularius*. In the first instance we used *Mastomys coucha* as the host. Numerous experiments were performed; but they failed to show that there was any statistically significant difference between the rate of development or the number of eggs laid by bugs reared on baby and adult rats. It was very obvious, however, that even adult *Mastomys* was a poor host for bed-bugs, since females laid considerably less eggs than when reared on adult white mice. We then turned to white mice, which had been used by Buxton, as experimental hosts. The results given in the accompanying table are significant. They show that there is no appreciable difference between the rate of development of the bugs reared on baby mice taken straight from the mother and those reared on the adult. However, there is a statistically significant difference between the numbers of eggs laid per female bug reared on 2-day old mice and those reared on adults. After two feeds on baby mice, the adult bugs were switched to an adult mouse for feeding, and egg production immediately increased and equalled that obtained by rearing bugs on adult mice alone. Unlike the fleas in Buxton's experiments, there was no delay in the production of eggs by females which had been reared on baby mice.

Further experiments were made in which bugs were reared on 10-, 20- and 30-day old white mice. The results showed that there was no difference in egg production between these groups, or between them and adult mice used in the experiments recorded in the table.

Buxton suggested that lack of mammalian sex hormones from the blood of baby mice may be the missing factor. This may be so, but it seems scarcely likely that at the age of ten days there will be sufficient sex hormones in circulation to affect the issue. It is, of course, well known that the blood of new-

Development and Egg Production of *Cimex lectularius*, when Reared on Adult and 2-day old White Mice

Host	Stages of development											No. of adult pairs	1st feed. Mean and S.D. of No. of eggs per female	No. of adult pairs	2nd feed. Mean and S.D. of No. of eggs per female	No. of adult pairs	3rd feed. Mean and S.D. of No. of eggs per female
	I	II		III		IV		V		Adult							
	No. fully fed	*P*	*T*	*P*	*T*	*P*	*T*	*P*	*T*	*P*	*T*						
Adult mouse	38	100	3·8 ±0·5	100	4·0 ±0·5	100	4·2 ±0·4	100	4·2 ±0·4	100	5·4 ±0·5	7	11·3 ±3·1	5	9·2 ±3·5	4	11·75 ±2·3
2-day old mouse	39	100	3·6 ±0·6	100	4·5 ±0·6	84	4·7 ±0·5	89	4·7 ±0·6	100	5·3 ±0·5	9	6·3 ±2·4	4	3·75 ± 2·6	3	9·0 ±2·8*

* Bugs fed on adult mouse. *P* = percentage of fully fed bugs which moulted. *T* = mean and standard deviation of time (in days) from feed to moult.

born animals differs in many respects from that of adults. We direct attention to one difference, namely, the normal disintegration of embryonic corpuscles, because there is some experimental evidence that hæmolysis does affect egg production in bedbugs. De Meillon and Golberg[3] have shown by *in vitro* feeding that, when bed-bugs are reared on hæmolysed blood, few or no eggs are produced, though the rate of development from first instar to adult is not materially affected. Secondly, we have found (unpublished work) that, when the blood is not hæmolysed, egg-production is approximately normal. It seems, therefore, that substances which inhibit egg production are produced or liberated in hæmolysed blood. The problem is,[3] however, unlikely to be a simple one, and it is merely suggested here that hæmolysis in the newborn may play some part in lowering egg-production in bed-bugs reared on baby mice.

We are grateful to Prof. P. A. Buxton for reading a draft of this letter and for making suggestions which we were glad to accept.

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Distribution of British Freshwater Amphipoda

During some recent work on the ecology of British freshwater amphipods, the following data on the distribution of the various species have emerged.

Eucrangonyx gracilis (S. I. Smith), a North American species, was first reported in Britain from Lea Bridge waterworks by Crawford[1], and has since been recorded by Bassindale[2] and Reid[3], from the Avon and other places in the Midlands, Oxford, Surrey and Middlesex. I have recently found it in large numbers, together with *Gammarus pulex* (L.), in the Welsh Dee, between Llangollen and Ruabon. This further extension of the recorded distribution indicates either that the species is spreading rapidly, or that, as Reid suggests, it has not really been introduced very recently, but has hitherto escaped detection.

Gammarus pulex (L.) was recorded from Lough Erne and Lough Keenaghan, in Ireland, by Sexton[4], on the basis of specimens, in the British Museum, collected by Major Trevelyan. The collections also contained specimens of another species, which Sexton identified as *G. zaddachi* Sexton. Reid[5] re-examined this material and decided that all the specimens were *G. duebeni* Lillj., except for a few *G. pulex* from L. Erne. Through the kindness of Dr. I. Gordon, of the British Museum, I have been able to re-examine these collections (numbered 1911.8.3.1–10), and I have found that the specimens from L. Keenaghan are a male and a female *G. lacustris* Sars, and those from L. Erne are a male and a female *G. duebeni* and a male and a female *G. lacustris*. All the specimens from the other lakes mentioned by Reid and Sexton (whose spelling of the names of the lakes does not quite agree with the labels on some of the tubes) are *G. duebeni*. This means that there are no undoubted records of the occurrence of *G. pulex* in Ireland. It should perhaps be pointed out that, when Sexton and Reid examined this material, *G. lacustris* was unknown in Britain.

Gammarus lacustris Sars has recently been recorded from a number of lochs in the Hebrides, Caithness, west Sutherland and west Ross-shire[2,6]. In 1949, I found this species in Llyn Idwal, Snowdonia, and in 1950 in Llyn Llywenan, Anglesey, where it was the only amphipod collected. In two similar lakes, Llyn Llygerian and Beaumaris Reservoir, only *G. pulex* was found. As shown above, *G. lacustris* occurs in L. Erne and L. Keenaghan in Ireland, and there are also two females and seven juveniles of this species in a tube in the British Museum labelled "Norman col'ection 1911.11.8. 18992 996 Lough Mask, Ireland 1903", which Reid[5] identified as *G. duebeni*. A similar tube but with the number 19036, which Reid also lists, contains one male *G. duebeni*. I have also seen specimens of *G. lacustris* collected in Calder Park, Glasgow, by Dr. H. D. Slack. This species is therefore widespread throughout Britain, and further search will probably reveal its presence in many lakes. I am indebted to Mr. D. M. Reid for confirming my identification of the specimens from Llyn Idwal.

Gammarus tigrinus Sexton[7] was described from saline waters in the Avon area, and has since been recorded from several localities in the Severn–Avon area, some of which are not particularly saline[2]. Bassindale states that Mr. G. M. Spooner has also seen specimens from Northern Ireland. There is a collection in the British Museum labelled "*Gammarus duebeni* 1945. VIII.10.1–5. S. Sömme Pres'd, N. Ireland, Portna, R. Bann. 12 & 13/4/45" which consists of four males, three females and five juveniles of what I have tentatively identified as *G. tigrinus*. It thus appears that this species also has a wide distribution.

Gammarus duebeni Lillj. is known from brackish water in many places on the British coasts[6] and from

fresh water in Ireland[6], the Isle of Man[8], Barra, Outer Hebrides[9], Cornwall and Anglesey (Crawford[10], and Dr. J. B. Cragg, in a personal communication). It is also known from fresh water in Iceland, the Faroes and Greenland, but elsewhere appears to be confined to brackish water. I am particularly interested in the freshwater distribution of this species, which I have been able to investigate only in Anglesey and the Isle of Man, and should very much welcome specimens or records from fresh water in Britain.

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Benzyl Alcohol as an Aid to Penetration of Certain Ovicides

In a study of penetration of insecticides through insect cuticle, Webb and Green[1] found that benzyl alcohol would greatly reduce the time required to kill sheep keds with diphenylamine, although the toxicity of the alcohol was slight. We have found in the course of two seasons work that benzyl alcohol will greatly increase the toxicity of certain ovicides towards the winter eggs of the fruit tree red spider mite, *Metatetranychus ulmi* (Koch). A large number of ovicides are ineffective against this egg at economic concentrations, and a means of increasing their efficiency would be of value.

Employing a dipping technique with lengths of apple twig bearing an adequate number of winter eggs, tests were made in 1949 of six compounds known to be toxic to the summer egg and, in some cases, to the winter egg of this mite, using a standard formulation, with and without 2·5 per cent benzyl alcohol. Except with diphenyl sulphone, the addition of benzyl alcohol increased the activity of the ovicide, while no kill due to this penetrant alone was observed. In the cases of dodecyl thiocyanate, azobenzene and azoxybenzene, levels themselves non-toxic became fully effective when the penetrant was added, and a similar, though less striking, increase was seen with diphenylamine; the toxicity of *bis*(*p*-chlorphenyl) methyl carbinol (DMC) was not affected very greatly, and diphenyl sulphone remained inactive. Thus, although the improved action of most of the toxicants used appears to be due to enhanced penetration, it does not necessarily follow that a good summer ovicide will become a good winter ovicide merely by incorporating a penetrant in the spray materials.

In 1950, an attempt was made to assess the minimum level of benzyl alcohol required to bring about considerable enhancement of activity against winter eggs, using the four ovicides shown to respond markedly in the previous year. The 1949 results were confirmed for all four compounds, and benzyl alcohol itself was shown to cause negligible kill even at 5 per cent. Using dodecyl thiocyanate at 0·05 per cent and azobenzene at 0·2 per cent, at least 2 per cent benzyl alcohol was required to give 95–100 per cent kill, and 5 per cent in the case of 0·2 per cent diphenylamine. Several combinations of azoxybenzene and benzyl alcohol were shown to give a complete kill, from 0·00625 per cent azoxybenzene plus 5 per cent benzyl alcohol to 0·05 per cent azoxybenzene plus 1·25 per cent benzyl alcohol. The latter is likely to be the most economical mixture of these two compounds.

In tests of materials having rather similar structure to that of benzyl alcohol, an increased mortality was obtained with each of the following when employed at 2 per cent with azoxybenzene at 0·03 per cent: *p*-tolyl carbinol, piperonyl alcohol, β-phenylethyl alcohol, 3-phenylpropyl alcohol, β-phenylethylamine, benzyl cresol and 2 : 4-xylen-1-ol. Of these, only benzyl cresol was toxic alone. Monoethanolamine, butyl cellosolve and α-phenylethylamine all reduced the activity of the azoxybenzene.

Benzyl alcohol was also tested as a penetrant for ovicides against the summer eggs of the fruit tree red spider mite, and the over-wintering eggs of the green apple aphis, *Aphis pomi* Deg., and the winter moth, *Operophtera brumata* L. In no case was any increase in the mortality due to various ovicides observed. Although the benzyl alcohol itself was somewhat toxic, the additive effects were less than those of the ovicides alone.

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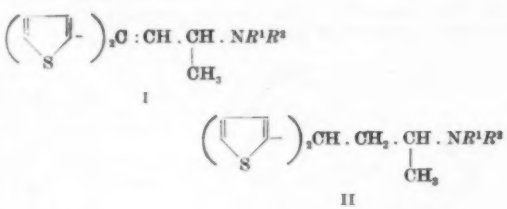
Dithienylbutylamines as Analgesics

The analgesic properties of a series of dithienylbutenylamines (I)[1] were described in a recent communication[2]. We now report that the corresponding saturated butylamines, the 1 : 1-di(2-thienyl)-3-tertiaryaminobutanes (II) similarly are potent analgesics.



I

II

The butylamines (II) were prepared by reduction (sodium and an alcohol) of the butenylamines (I). The completeness of reduction was confirmed by the absence in the ultra-violet spectrum of the absorption band characteristic of the dithienylethylene moiety of the butenylamines. In addition, solutions of the butylamines in concentrated hydrochloric acid remained colourless when warmed, whereas an intense blue colour developed when minute quantities of the butenylamines were so treated.

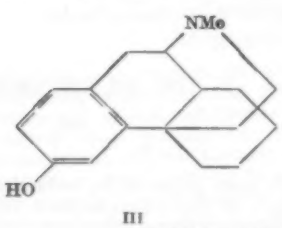
The new compounds (II) have the same qualitative pharmacological effects in several laboratory animals as the butenylamines[2]; but their analgesic potency when assessed in the young rat (30–40 gm.), as shown

Compound	Formula II		Analgesic activity (*P*. 95 limits)
	NR^1R^2	Salt	
a	NMe_2	Hydrochloride, m.p. 162°	0·21 (0·17–0·26)
b	NEt_2	,, 123–125°	0·26 (0·19–0·36)
c	$N<(CH_2)_5>CH_2$	,, 154°	0·25 (0·19–0·33)
d	$N<(CH_2)_4>CH_2$	Hydrogen oxalate, 111–112°	0·24 (0·19–0·29)
e	$N<[CH_2]_4>O$	Hydrochloride, 185–186°	0·055 (0·045–0·067)
Morphine			1·0

in the table, is less. In the dog, the compound *a*, which has been the most extensively investigated, causes analgesia and hypnosis by subcutaneous injection at a dose of 10–20 mgm./kgm. without undesirable side-effects such as vomiting. The estimated analgesic potency here is 0·16 times morphine (*P*. 95 limits, 0·10–0·26). Thus, there is no marked drop in relative activity when the rat is replaced by the dog as test animal, in contrast with that observed with the analogous butenylamines[2]. The compound *a* is poorly tolerated by the dog when given by mouth.

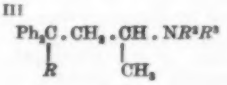
It is of considerable theoretical interest that the nature of the analgesic and other pharmacological properties is not greatly altered by saturation of the ethylenic linkage of the butenylamine structure (I). Other variations in the structure (I), such as substitution in the thienyl groups; replacement of one or both thienyl groups by phenyl; replacement of the methyl side-chain by other groups or a change in its position to the β-carbon atom resulted in diminished analgesic potency. These changes applied to the butylamine structure (II) similarly gave less-active compounds.

A quaternary carbon atom in the γ-position to a tertiary amino-group is a structural feature common to morphine, the related 3-hydroxy-*N*-methylmorphinan (III) and all the synthetic potent analgesics hitherto known, namely, the pethidine type (for example, IV; $R = CO_2Et$, COEt), the related piperidinols (for example, IV; R = OCOEt) and the amidone group (V; R = COEt, CH(OCOMe)Et, SO_2Et)[3]. The recognition of this has led some workers to the view that it is an optimal, and perhaps essential, feature of potent analgesics, and recently the synthesis of new series of analgesics has been based on this concept[4,5]. The new compounds (II) have no such quaternary carbon atom.



III

IV



V

The many variations which have been made to structures (I) and (II), briefly referred to above, will be described in greater detail elsewhere. It is of interest to record here that two butenylamine hydrochlorides (I; $NR^1R^2 = NMe_2$, $N<[CH_2]_3>CH_2$) have been resolved into their optical isomers; the analgesic activity resides mainly in the *dextro* isomers, in contrast with amidone, where the *lævo* isomer is the more active[6].

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[1] Adamson, D. W., *J. Chem. Soc.*, 885 (1950).
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Photodisintegration of the Deuteron at some Intermediate Energies and the Neutron-Proton Effective Triplet Range

An earlier communication[1] gave the results of measurements of the cross-section for the photodisintegration of the deuteron by gamma-rays of 6·1 and 17·6 MeV. These measurements have been extended to other gamma-ray energies with the object (1) of determining whether the form of the variation of cross-section with energy is in accord with the theoretical prediction and (2) of measuring the effective range for triplet neutron–proton interaction[2–6].

For the gamma-ray energies used in this work the cross-section for the photo-electric disintegration is governed almost solely by this effective range[4–6]; but small differences exist between the predictions based on a tail-less 'square' well and those based on a long-tailed well of the Yukawa or exponential type. We have analysed the results in terms of the square well and Yukawa well, and have deduced effective triplet ranges for the two types. (For the square well the asymptotic form of the wave function of the deuteron ground-state was used in evaluating the electric dipole matrix element: this results in little error. For the Yukawa well the matrix element was corrected with the aid of the convenient approximation of Hulthén.) A small calculated correction for the photomagnetic disintegration cross-section σ_m has been applied to the total cross-section σ_t to find the desired photo-electric cross-section σ_e. (The correction used is that appropriate to a Yukawa well, but is insignificantly different from that for a square well.) Quadrupole effects are nowhere greater than 3×10^{-30} cm.^{2} and are negligible[5,6]. The analysis is based on the commonly used 50–50 mixture of exchange and ordinary forces corresponding to zero interaction in the final ^3P state; the uncertainty introduced by this assumption is small. The accompanying table displays the results of the experiments and their analysis.

The gamma-ray energies are in MeV., the cross-sections in units of 10^{-28} cm.^{2}, the ranges in units of 10^{-13} cm., the uncertainties are probable errors,

E_γ	σ_t	σ_m	σ_e	ρ'_{ts}	ρ'_{ty}
4·45	24·3 ± 1·7	1·01	23·3	1·68	1·70
6·14	21·9 ± 1·0	0·59	21·3	1·75	1·78
7·39	18·4 ± 1·5	0·44	18·0	1·68	1·73
8·14	16·4 ± 1·2	0·39	16·0	1·60	1·65
12·5	10·4 ± 1·0	0·22	10·2	1·62	1·73
17·6	7·7 ± 0·9	0·14	7·6	1·94	2·11

and a binding-energy for the deuteron of 2·227 MeV.[7] has been used. The weighted means of the effective ranges, ρ'_{ts} for the square well and ρ'_{ty} for the Yukawa, are 1·71 and 1·76 × 10^{-13} cm. respectively. We prefer the value derived from the more physically reasonable long-tailed potential and quote

$$\rho'_t = (1{\cdot}76 \pm 0{\cdot}09) \times 10^{-13} \text{ cm.}$$

There is no significant dependence of ρ'_t on E_γ, so the variation of σ_e with E_γ indeed accords with theory. Now the effective range ρ'_t refers to the ground-state of the deuteron, $\rho_t(-\varepsilon, -\varepsilon)$ in the notation of Bethe[3]. It is of interest to derive the two other important effective ranges, $\rho_t = \rho_t(o, -\varepsilon)$ and $r_{ot} = \rho_t(o, o)$. This can be done with the aid of the curves published by Blatt and Jackson[2], when we find, for the two wells,

$\rho_t(-\varepsilon, -\varepsilon) = 1{\cdot}76$		$= 1{\cdot}71$
$\rho_t(o, -\varepsilon) = 1{\cdot}69$	(Yukawa)	$= 1{\cdot}73$ (Square)
$\rho_t(o, o) = 1{\cdot}62$		$= 1{\cdot}75$

Hughes, Burgy and Ringo[8] measured the neutron–proton coherent scattering-length, and their work, combined with that of Melkonian[9] on the scattering cross-section of free protons for slow neutrons, yields a triplet effective range, $\rho_t = (1{\cdot}72 \pm 0{\cdot}05) \times 10^{-13}$ cm. This figure agrees well with the alternatives 1·69 and 1·73 × 10^{-13} cm. derived here for the Yukawa and square wells; but the present experimental inaccuracies do not permit of any discrimination between these two extreme wells. The gamma-rays listed above were derived, in turn, from the proton bombardment of nitrogen-15, fluorine-19, beryllium-9, carbon-13, boron-11, and lithium-7 [10].

We wish to thank Sir John Cockcroft and Dr. W. D. Allen, of the Atomic Energy Research Establishment, Harwell, who supplied some separated isotopes, Mr. C. A. Barnes, who helped with the measurements at 7·4 MeV., and also Dr. E. E. Salpeter for a private communication. One of us (J. H. C.) thanks the Australian National University for the award of a travelling scholarship.

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D. H. Wilkinson

Cavendish Laboratory,
Cambridge. Sept. 19.

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Half-life of Bromine-82

Snell[1] first reported that the half-life of radioactive bromine-82 was 33·9 ± 0·1 hr. Berne[2] has recently determined the half-life of this isotope and reported a value of 36·0 ± 0·1 hr. Chiang and Willard[3] suggested that the half-life is nearer 35 hr. than the generally quoted value of 34 hr.[4].

The mean value of fourteen independent determinations of the half-life of this isotope, made in the course of tracer experiments at this Laboratory, was 35·1 hr. The mean was weighted according to the time interval (42–256 hr.) between the two measurements of each determination. The standard error of the mean was ± 0·13 hr. The bromine-82 was extracted from A. R. monobromobenzene irradiated in the Harwell pile. All the radioactivity measurements were made in a liquid-counter of the type described by Veall[5], the isotope being present as a solution of a labelled compound of the type ($Br^*C_6H_4{}^1{}_2CH.CCl_3$. In all cases the bromine-80 isomers had decayed to insignificance. Possible contamination by phosphorus-32 and sulphur-35 (arising from chlorine impurities in the irradiated compound) was eliminated chemically by the methods of extraction and synthesis; in any event the counter was not sensitive to sulphur-35. Residual activity of aged samples, possibly due to chlorine-36, was never detected. The counter was externally quenched for a period of 400 μsec. (as checked on a cathode-ray oscillograph) and the appropriate 'dead-time' corrections applied for different rates of counting. Significant variations in the over-all counting efficiency of the assembly were obviated by counting a reference solution of acidified uranium sulphate.

Wilk[6] has obtained evidence that the thermal-neutron capture cross-section for the reaction, $^{35}Cl(n,p)^{35}S$, may be twenty times greater than the earlier reported value of 0·13 barn[7]. Reagent bromides may contain up to 0·25 per cent of chloride[8]. On the basis of these data, it can be shown that a determination of the half-life of bromine-82, using a pile-irradiated bromide which had been left sufficiently long for the bromine-80 isomers to decay away, could be in error by more than 1 per cent unless the effects due to sulphur-35 alone were eliminated. This possibility appears to be confirmed by Ruka and Willard[9], who found a considerable sulphur-35 activity in their irradiated bromides, and it is believed that the high value for the half-life of bromine-82 (36 hr.) reported by Berne[2] might be due to this.

These observations are published by permission of the Department of Scientific and Industrial Research.

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Oct. 31.

[1] Snell, A. H., *Phys. Rev.*, **52**, 1007 (1937).
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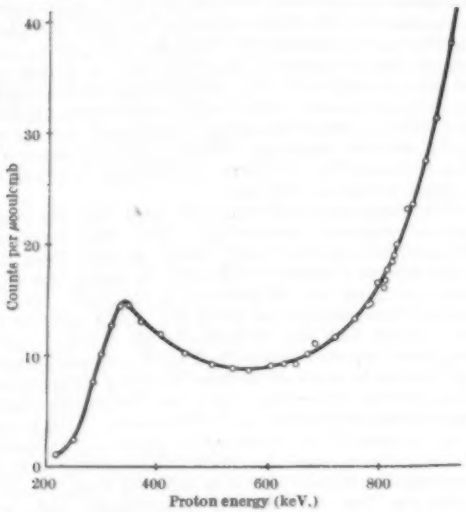
Thin-Target Yield of $^{15}N(p,\alpha)^{12}C$

In an earlier investigation[1] of the reaction $^{16}O(p,\alpha)^{13}N$, a target technique with isotopically separated gas bound in a metal lattice was used. In the present investigation the same method has been used for a study of the relative yield of the reaction $^{15}N(p,\alpha)^{12}C$. Thin targets of nitrogen-15 were prepared in the electromagnetic isotope separator by bombarding silver plates with the beam of mass number 15 for about five hours, the ion source containing nitrogen. Immediately after the separation, these targets were put into the vacuum system of the high-tension accelerator.

During proton bombardment, the thin-target yield of α-particles leaving the carbon-12 nucleus in its ground-state was studied at 90° to the incident beam. The experimental arrangements and precautions were mainly the same as those described earlier[1]. The range of the α-particles counted was in agreement with the Q-value of $^{15}N(p,\alpha)^{12}C$.

One resonance, at 340 keV., has been found in the energy region 220–940 keV. The yield curve is shown in the accompanying graph. This is the resonance that Cochrane and Hester[2] found in the neighbourhood of 400 keV.



Because of the special interest of the reaction $^{15}N(p,\alpha)^{12}C$—the last reaction in the carbon cycle—Holloway and Bethe[3] have measured the absolute cross-section at one proton energy, 360 keV., getting $1{\cdot}3 \times 10^{-26}$ cm.^{2}. Cochrane and Hester found $\sigma_R = 1{\cdot}4 \times 10^{-26}$ cm.^{2}.

The details of our (p,α)-investigations will be published in *Ark. f. Fysik*.

We wish to thank Messrs. I. Bergström and S. Thulin for preparing the targets in the isotope separator.

Note added in proof. Schardt *et al.*[4] give $E_R = 0{\cdot}36$ MeV., $\sigma_R = 9 \times 10^{-26}$ cm.^{2}.

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Life-time of the Lithium Atomic Resonance States

Numerous experimental methods have been devised for the measurement of the life-times of atomic states (for a general survey see Mitchell and Zemansky[1]). One method of particular interest is the total absorption method, which involves the integral of the absorption coefficient K_ν over the whole absorption line and does not depend on a knowledge of the broadening processes responsible for the formation of the line. This method has been used[2] for obtaining the life-time of the lithium resonance states and the oscillator strength corresponding to the transition $(2^2S_{1/2} - 2^2P)$ λ 6708 A.

The Ladenburg absorption formula[3] relating the integral of the absorption coefficient over the whole line to the Einstein transition probability coefficient A_{nm} may be conveniently put in the form

$$\int \log_e \left(\frac{I_0}{I_\nu}\right) d\lambda = \frac{\pi N f e^2 l \lambda_0^2}{mc^2}, \qquad (1)$$

where N is the number of normal atoms of absorbing vapour per c.c., λ_0 the wave-length of the absorbed radiation, l the length of the absorbing column, f the oscillator strength, and I_0, I_ν the intensities of the incident and emergent radiation.

The value of this integral was obtained by photographic densitometry of the spectrogram and carrying out a graphical integration of the area under the curve, the photographic plates first being calibrated for density of blackening against intensity of incident radiation. Throughout the work results were obtained with a 10-ft. grating instrument in the first order (dispersion 5·46 A./mm.) and with a slit-width of 0·03 mm. It was found that the correction to the line profile due to the finite slit-width was negligible. By working in the first order, the resolving power of the spectrograph was insufficient to resolve the doublet nature of the λ 6708 A. resonance line; and the profile obtained, therefore, corresponded to the sum of the intensities of the two transitions $(2^2S_{1/2} - {}^2P_{1/2})$ and $(2^2S_{1/2} - 2^2P_{3/2})$.

Owing to the strong chemical activity of lithium vapour on most forms of glass and quartz, it was found necessary to use a nickel absorption tube with lithium fluoride windows. This absorption tube charged with lithium was placed in a vacuum-tight furnace and heated to the required temperature in the presence of an inert gas pressure of 10 cm. of argon. Plates were taken of the absorption spectrum at a mean uniform temperature of 679·0° K., and the value of N obtained from the vapour pressure formula given by Kelley[4],

$$\log_{10} p_{mm} = 7{\cdot}50 - \frac{7480}{T}, \qquad (2)$$

where p_{mm} is the vapour pressure in mm. and T the absolute temperature. The value of the integral in equation (1) was found to be $1{\cdot}29 \times 10^{-3}$ cm.$^{-1}$, corresponding to a temperature of 679° K. and a wave-length of 6708 A. (the length of the absorbing column being 1·02 cm.). The f-value finally obtained for the transition $(2^2S - 2^2P)$ was $0{\cdot}72 \pm 0{\cdot}03$, corresponding to a life-time of $2{\cdot}8 \times 10^{-8}$ sec. for the resonance states. This result is in close agreement with the theoretical value of $2{\cdot}7 \times 10^{-8}$ sec. obtained by the Bates–Damgaard[5] method and the mean f-value of 0·71 quoted by Landolt–Bornstein[6].

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Oct. 17.

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[3] Ladenburg, R., *Z. Phys.*, **4**, 451 (1921).
[4] Kelley, K. K., Bureau of Mines Bull., No. 383 (1935).
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[6] Landolt–Bornstein, Pt. 1, 264 (Berlin, 1950).

Role of Dissolved Oxygen during the Inhibition of the Corrosion of Iron by Sodium Phosphate Solutions

It was recently suggested by Mayne, Menter and Pryor[1] that dissolved oxygen is primarily responsible for the ability of 0·1 *N* sodium hydroxide solution to inhibit the corrosion of iron, by virtue of a heterogeneous reaction with surface iron atoms to form a thin film of γ-Fe_2O_3. The present investigation was undertaken to determine the effect of dissolved oxygen on the corrosion-rate of iron totally immersed in solutions of sodium phosphate at different *p*H values.

The specimens, measuring 2·5 cm. × 0·5 cm., were cut from sheet 0·02 cm. thick having the analysis: C, 0·005; Si, 0·0075; S, 0·013; P, 0·003; Mn, 0·007; Ni, 0·018; Cr, 0·02; Cu, 0·003; O, 0·12; N, 0·018; H, 0·00009 per cent. Each specimen was degreased in benzene, abraded with 3/0 emery paper, swabbed with acetone and weighed immediately before the beginning of the experiment. The solutions were prepared by mixing *M*/10 solutions of mono- and di-sodium phosphate to give a *p*H range of 4·5–9·1 with a constant phosphate content.

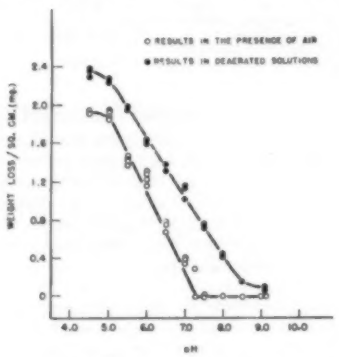

Fig. 1. Curves relating loss of weight per sq. cm., in five days, (*a*) in the presence of dissolved air, (*b*) in deaerated solutions, to the *p*H of solutions of constant phosphate content at 25 ± 0·05° C.

In the first series of experiments, specimens were fully exposed to 5 ml. of solution saturated with air, and in free contact with the atmosphere, for five days, all runs being carried out in a water thermostat at 25 ± 0·05° C. At the end of the run the corrosion product was removed by 20 sec. exposure to 1 : 1 hydrochloric acid inhibited with 3 per cent 'Rodine'; exposure of a clean specimen to this solution for 300 sec. resulted in a loss of weight of less than 0·05 mgm. The specimens were then washed with water, dried with acetone, swabbed with benzene and finally re-weighed. The results (Fig. 1) show that passivity is obtained at *p*H values above 7·25.

Experiments under anaerobic conditions were carried out in the apparatus shown in Fig. 2, which involved the large change in gaseous solubility on freezing the solution. With the exception of the removal of dissolved air, other conditions were the same as in previous experiments in the presence of air. The specimen was contained in the limb *A* and the solution in *B*. Deaeration consisted of five cycles in which the solution was first frozen with liquid nitrogen, the tap *D* then opened to the vacuum system, at a pressure of 10^{-5} mm. of mercury, for

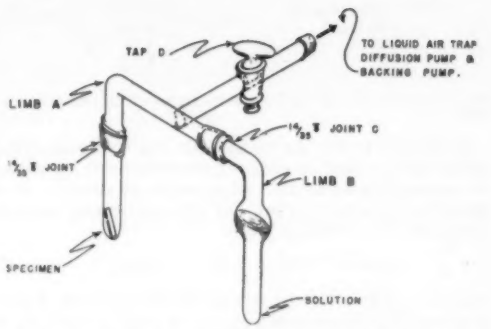

Fig. 2. Apparatus for experiments under anaerobic conditions

ten minutes and finally *D* closed and the frozen solution in *B* allowed to melt. During the fifth cycle, air was desorbed from the walls of the apparatus by gentle heating with a smoky flame. The solution was transferred into limb *A* by rotating limb *B* about the 14/35 standard-taper joint *C*; the apparatus was then removed from the vacuum line and placed in a thermostat at 25 ± 0·05° C. The results, also plotted in Fig. 1, show that once dissolved oxygen is removed from the phosphate it does not inhibit the corrosion of iron. The corrosion product in the absence of oxygen is a colourless tabular crystalline deposit.

Further work is being carried out on this subject and will be published at a later date.

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Aug. 3.

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Electrical Conductivity of Borax Glasses containing Dispersed Gold

It will appear from previous communications[1] regarding X-ray diffraction patterns of alkali metal salts, gold and platinum dispersed in borax glass that gold (with which we are concerned here) and also platinum exist as finely divided crystallites in the medium. The magnetic susceptibility of such samples has also been studied[2].

The object of this note is to communicate certain interesting indications obtained in measuring the electrical conductivity of borax glass containing dispersed gold. The samples were prepared in the way similar to those described in the previous communications, and their electrical conductivities were calculated by obtaining the dimensions and the resistance of the sample from the drop of voltage across it and the current passing through it. The D.C. voltage (converted from A.C. mains through a transformer and a diode rectifier) used ranged from 150 to 450 volts. A standard resistance of 1 megohm had to be used in series with a 15-volt standard voltmeter to get the required range of voltage. The current through the sample was of the order of 10^{-6} amp. and was measured by a shunted d'Arsonval galvanometer having a figure of merit of the order of 10^{-10} amp. per mm. The percentages of gold in the samples were measured colorimetrically[3]. The results obtained are correct within ± 5 per cent.

Percentage of gold	$\sigma \times 10^6$ mhos per cm.
0·00 (base)	3·66
0·15	4·20
0·26	5·13
0·60	8·98

where σ is the specific conductivity of the sample of glass with dispersed gold.

Attempts to fit the data with the colligative law failed and yielded an order of the conductivity values of dispersed gold as 10^{-6} mho, which is absurd. It is observed, however, that the above results roughly obey the empirical relation

$$100\sigma = (100 - p)\sigma_1 + p^3 k\sigma_2, \qquad (1)$$

where σ_1 and σ_2 are the specific conductivities of pure glass and gold respectively ($\sigma_1 = 3{\cdot}66 \times 10^{-6}$, $\sigma_2 = 4{\cdot}13 \times 10^6$) in mhos per cm. and p is the percentage of gold in the sample. The calculated values of $k\sigma_2$, which should be constant if (1) is to hold, are as follows :

Percentage of gold	$k\sigma_2 \times 10^4$
0·15	0·24
0·26	0·22
0·60	0·15

The gradual fall in the values of $k\sigma_2$ appears from the above table to be almost linear in p, and in the light of this (1) can be modified by adding a negative term containing p^3 ; but the introduction of this term (which only fits the observations by introducing a two-parameter empirical relation in an observation containing only three results) cannot be wholly justified without further observations.

The results as conveyed by the empirical relation (1) indicate a decrease in the effective conductivity (by which term is meant the conductivity, σ'_2, which should enter in the colligative formula $100\sigma = (100-p)\sigma_1 + p\sigma'_2$) of gold proportional to the percentage of gold present in the sample. This may be considered as due to the effect of the glass media, though the conjectures we have about the exact mechanism of this reduction cannot at present be stated with any definiteness without further investigations. The details of this investigation are being published elsewhere.

We thank the Government of West Bengal for a financial grant which has made the investigation possible.

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Gaganbihari Bandyopadhyay
Sunilkumar Datta

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Darjeeling.
Sept. 16.

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[2] *Nature*, **161**, 684 (1948).
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Accurate Potentials with the Dropping Mercury Cathode

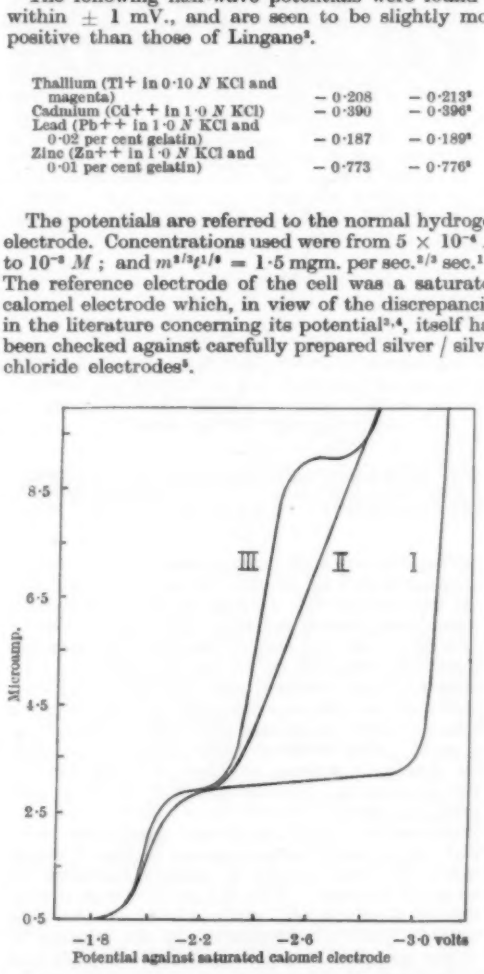
The accuracy of the measurement of half-wave potentials has been limited by the magnitude of the ohmic potential term for the cell. They can be determined accurately, however, even in solutions of high resistance, if the three-electrode cell is used[1].

It has been stated[2] that the ohmic potential term for this cell is negligible for certain conditions of low concentration, resistance and mercury flow ; but under conditions of high concentration, resistance and mercury flow, the question of a correction for ohmic potential still does not arise, as can be seen from the following considerations. (i) The null-point galvanometer of the potentiometer across the cathode and the third (reference) electrode is adjusted to zero current ; hence the potential measured is that of the mercury/solution interface against the reference electrode only, so that the ohmic potential term is always zero. (ii) If this were not so, the half-wave potential should apparently increase with greater distance apart of the three electrodes, since this would increase the resistance of the cell. It has been shown in this laboratory that this is not so. Moreover, with thallium and lead, the potentials are constant for increase in the rate of flow of mercury, showing that for the ions of cadmium and zinc, where the potential becomes more negative, this increase is a function of the rate of growth of the electrode surface rather than the ohmic potential.

The following half-wave potentials were found to within $\pm$ 1 mV., and are seen to be slightly more positive than those of Lingane[3].

Thallium (Tl+ in 0·10 *N* KCl and magenta)	− 0·208	− 0·213[3]
Cadmium (Cd++ in 1·0 *N* KCl)	− 0·390	− 0·396[3]
Lead (Pb++ in 1·0 *N* KCl and 0·02 per cent gelatin)	− 0·187	− 0·189[3]
Zinc (Zn++ in 1·0 *N* KCl and 0·01 per cent gelatin)	− 0·773	− 0·776[3]

The potentials are referred to the normal hydrogen electrode. Concentrations used were from 5×10^{-6} *M* to 10^{-3} *M* ; and $m^{2/3}t^{1/6} = 1{\cdot}5$ mgm. per sec.$^{2/3}$ sec.$^{1/6}$. The reference electrode of the cell was a saturated calomel electrode which, in view of the discrepancies in the literature concerning its potential[2,4], itself had been checked against carefully prepared silver / silver chloride electrodes[5].



Curve I, supporting electrolyte of 0·1 *M* $(C_4H_9)_4NOH$ in 62 per cent dioxane with 7×10^{-4} *M* NaI as internal standard ; curve II, $1{\cdot}07 \times 10^{-3}$ *M* 2-methylnaphthalene with the two-electrode cell ; curve III, $1{\cdot}07 \times 10^{-3}$ *M* 2-methylnaphthalene with the three-electrode cell. $m^{2/3}t^{1/6} = 1{\cdot}29$ mgm. per sec.$^{2/3}$ sec.$^{1/6}$

(iii) For a polarogram of 2-methylnaphthalene in a supporting electrolyte of tetrabutylammonium hydroxide in 62 per cent dioxane, the ohmic potential term using the conventional two-electrode circuit was about 0·2 V. The waves showed apparently high irreversibility[6], and accuracy of measurement was not possible to within ± 10 mV., as can usually be given for organic reductions. Polarograms recorded for Mr. L. E. Lyons with the three-electrode circuit are shown. The improvement is obvious.

The half-wave potentials were for sodium, − 1·982 V., and 2-methylnaphthalene, − 2·408 V. Logarithmic analysis of the waves gave slopes of − 0·060 V. for sodium and − 0·085 V. for 2-methylnaphthalene.

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Aug. 1.

[1] Lingane, J. J., and Kolthoff, I. M., *J. Amer. Chem. Soc.*, **61**, 825 (1939).
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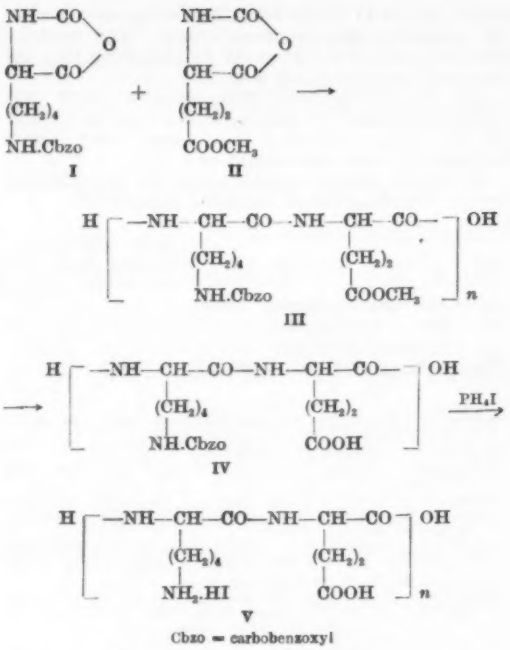
A Synthetic Amphoteric Polypeptide

The amphoteric ionic behaviour, one of the characteristics of proteins, has been considered to be due to the presence of the amino- and the carboxyl-groups in the side-chains of the polypeptide chain. Since the natural proteins consist of various amino-acids, and their structures are very complex, it is desirable, in order to study this particular property, to prepare an ampholyte of a simple structure containing many amino- and carboxyl-groups.

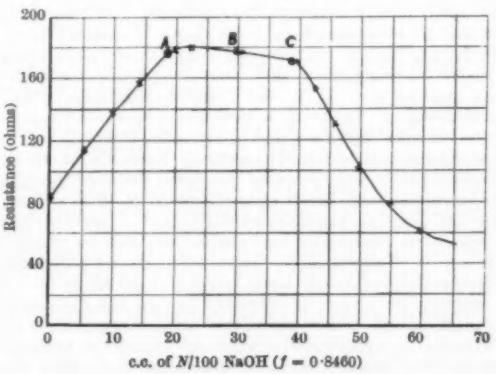
Recently, Alfrey and his associates[1] called a copolymer obtained from α-vinyl pyridine and methacrylic acid "synthetic electrical analog of protein". We have also obtained recently an ampholyte[2] of molecular weight about 10,000, containing both amino- and carboxyl-groups from a copolymer prepared by the interaction of methyl methacrylate and vinyl phthalimide. The backbone chains of the polymers prepared by Alfrey and by us consist of a chain of carbon atoms. We have now succeeded, for the first time, in synthesizing an amphoteric polypeptide consisting of lysine and glutamic acid.

The method of synthesis was as follows. A mixture of ε-N-carbo-benzoxy-DL-lysine-α-N-carbonic anhydride[3] (I), of melting point 100°, and γ-methyl-L-glutamate-N-carbonic anhydride[4] (II), of melting point 100° C., in equimolecular proportions was heated to 98–99° for 100 hr., using ethyl phenylacetate[5] as a solvent. A polymer (III) was obtained as a gelatinous precipitate. When (III) was treated with a dilute solution of alkali, γ-methyl esters of the glutamic acid component were hydrolysed to give a material of light yellow colour (IV) in granules. Reductive removal of the carbobenzoxyl groups of the lysine component with phosphonium iodide was then carried out, giving the hydroiodide of the amphoteric polypeptide as a colourless hygroscopic solid. An overall yield of these reactions was 2·5 gm. from 11 gm. of a mixture of the carbonic anhydrides.



Cbzo = carbobenzoxyl

The polypeptide thus obtained shows a strong biuret reaction, is readily soluble in water and soluble in ethanol, and shows a tendency to be salted out from its aqueous solution by the addition of a concentrated salt solution. It has been indicated that the polypeptide consists of approximately an equimolecular ratio of glutamic acid and lysine, from the results obtained by the iodine determination of the hydroiodide (found, 35·00 per cent; cal. 33·00 per cent), by the free amino-nitrogen determination by micro–van Slyke (found, 3·82 per cent; cal., 3·64 per cent) and by the total nitrogen determination by micro–Kjeldahl (found, 10·09 per cent; cal., 10·92 per cent). In addition, the accompanying potentiometric titration curve gives further evidence. Ten millilitres of an aqueous solution of the hydroiodide (0·618 per cent) was titrated with a solution of $N/100$ sodium hydroxide. Point A on this curve indicates the free amino-nitrogen as 3·65 per cent and iodine 33·0 per cent, and point C the free carb-



oxylic acid as 11·72 per cent, in good agreement with the respective results noted above. The solution showed a *p*H of 6·8 at point *B*, indicating that its isoelectric point is about 6·8.

An osmotic pressure determination[7] with the dialysed solution of the hydroiodide (conc. 0·558 gm./l.; $d_{30.2^\circ} = 1.001$; $\pi = 2.448 \times 10^{-3}$ atm.) indicated a molecular weight of 5,700.

A detailed account of this work will be published in the *Journal of High Polymers, Japan*.

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Sept. 8.

[1] Alfrey, T., Morawetz, jun., H., Fitzgerald, Z. B., and Fuoss, R. H., *J. Amer. Chem. Soc.*, **72**, 1804 (1950).
[2] Tani, H., and Noguchi, J. (unpublished).
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[6] Noma, K., and Tsuchida, T., *J. High Polymers, Japan*, **6**, 282 (1949) have shown that ethyl phenylacetate is a good solvent in the polymerization of the compound (I).
[7] The osmotic pressure was determined by the simplified dynamic method. (cf. Mesituka, G., *J. High Polymers, Japan*, **6**, 305 (1949).)

Definitions in Biology

MAY I support Prof. Alan Boyden's plea[1] that parthenogenesis should not be classified as asexual reproduction? The habit of doing so presumably arose because the text-book definition of sexual reproduction excludes anything which does not involve fusion of gametes; but such a reliance on a definition instead of on the facts implies a degree of philosophical realism which has no proper place in science.

Biology, unlike logic and mathematics, has to take the world as it finds it. Definitions are descriptions of concepts or phenomena, sometimes of arbitrary stages in a series, and when they are made short they inevitably become inaccurate. Prof. Boyden himself falls into difficulty in proposing to re-define (or, as he puts it, characterize) sexual reproduction as "reproduction which involves gamete formation", for a gamete is usually defined as a cell which fuses with another cell. And can the hologametes of *Polytoma* be said in any sense to be "formed"? It is much better to recognize frankly that, while definitions of biological terms may be convenient as mnemonics and in teaching, they must never be used as the basis for argument. It is well known that no formal definition of 'gamete' is possible, since sometimes, as in *Amœba diploidea* and many eggs, the cells which begin fusing are not the same individuals as those which finish the process, nuclear division having intervened, and Pirie[2] has argued that 'life' cannot be defined. No satisfactory definition of 'species' has ever been made. One of the latest, that of Mayr[3], is quite inadequate; apart from being formally incorrect in stating that a species is a group of populations, which it certainly is not, his definition would, since it contains the term 'interbreeding', exclude *Amœba proteus* and all creatures without cross-fertilization. Similar difficulties arise with the words cell, reproduction, tissue, skeleton, parasite and many others. The advice "Define your terms" is bad counsel to give to biologists, for where the observations to be described have no sharp limits, if definition makes the argument simpler it does so at the expense of truth.

W. B. YAPP

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Nov. 17.

[1] Boyden, A., *Nature*, **166**, 820 (1950).
[2] Pirie, M. W., "The Meaninglessness of the Terms Life and Living" in "Perspectives in Biochemistry", Ed. J. Needham and D. E. Green (Cambridge, 1937).
[3] Mayr, E., "Systematics and the Origin of Species" (London, 1942).

Orthography of the Scientific Names in Zoology

PRELIMINARY consideration was given to the orthography of the scientific names of animals in 1948 in Paris both by the International Commission on Zoological Nomenclature and by the International Congress of Zoology. It was recognized that the provisions relating to this (Article 19) in the "Règles Internationales de la Nomenclature Zoologique" are quite inadequate, for the three conditions in which, under that Article, the original spelling of a scientific name must be emended all involve subjective judgments on the part of the reader; thus it provides that a name is to be emended where it is "evident" that the original spelling of a name is defective by reason of (1) a "faute d'orthographe", (2) a "faute de transcription", or (3) a "faute d'impression". Clearly what is "evident" to one zoologist may be the reverse to others, and in consequence provisions of this kind can never secure the principal object sought by zoologists, namely, stability in zoological nomenclature.

The Paris Congress took the view that it was impossible on that occasion to deal with this subject, owing partly to the intrinsic complexity of the issues involved and partly to the considerable divergence of opinion and practice in this matter in zoological literature. The Congress recognized, however, that this was a matter on which it is desirable that a clear decision should be taken with as little further delay as possible, and accordingly decided to request the Secretary to the International Commission on Zoological Nomenclature, in consultation with interested specialists, to prepare a comprehensive report, with recommendations for consideration by the next Congress at Copenhagen in 1953.

I am most anxious that the report which the Congress has asked me to prepare shall be as broadly based as possible, and for this purpose it will be of great assistance if zoologists and palæontologists interested in this question will be so good as to let me have statements setting out the general objects which they consider the revised provisions should seek to achieve and, in particular, details of the questions which, in their opinion, should be covered by those provisions.

FRANCIS HEMMING
(Secretary to the International Commission on Zoological Nomenclature)

28 Park Village East,
Regent's Park,
London, N.W.1.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 29

UNIVERSITY OF LONDON (at the Institute of Neurology, National Hospital, Queen Square, London, W.C.1), at 5 p.m.—Prof. H. Hartridge, F.R.S.: "Some Recent Advances in the Neuro-physiology of Vision".*

Tuesday, January 30

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS AND RADIO SECTIONS (joint meeting with the Royal Meteorological Society, at Savoy Hill, Victoria Embankment, London, W.C.2), at 3 p.m.—Symposium on "Electrical Meteorological Instruments".

ROYAL SOCIETY OF ARTS, DOMINIONS AND COLONIES SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. G. F. Clay: "The Contribution of the Colonial Empire to World Food Supplies" (Henry Morley Lecture).

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Discussion on "Drying Technique" (A Study of Drying, 4).*

UNIVERSITY OF LONDON (in the Chemistry Lecture Theatre, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 5.30 p.m.—Mr. F. C. Bawden, F.R.S.: "The Development of Knowledge on Plant Viruses".*

SOCIETY OF DYERS AND COLOURISTS, MANCHESTER JUNIOR BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 6.30 p.m.—Mr. F. W. Bradley: "The Application of Metallizable Dyestuffs".

SOCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Mr. K. J. B. Wolfe and Mr. P. Spear: "The Machining of Small Instrument Parts".

SHEFFIELD METALLURGICAL ASSOCIATION (at the Grand Hotel, Sheffield), at 7 p.m.—Mr. E. A. G. Liddiard: "The Welding of Non-Ferrous Metals".

Wednesday, January 31

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. H. H. Read, F.R.S., and Mr. O. C. Farquhar: "The Geology of the Arnage District (Aberdeenshire), a Re-interpretation"; Miss Nancy H. Kirk: "The Upper Llandovery and Lower Wenlock Rocks of the area between Dolyhir and Presteigne, Radnorshire".

ROYAL STATISTICAL SOCIETY, RESEARCH SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Prof. G. A. Barnard: "The Theory of Information".

PHYSICAL SOCIETY, COLOUR GROUP (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Prof. H. Moore: "Analysis of the Colours of Glasses containing Iron".

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Dr. A. W. Brewer: "The Nucleation of the Ice Phase".

MANCHESTER METALLURGICAL SOCIETY (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. J. Preston: "The Metallurgy of Titanium".

Thursday, February 1

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. L. F. Gilbert: "William Hyde Wollaston".*

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3 p.m.—Scientific Papers.

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. J. T. Randall, F.R.S.: "An Experiment in Biophysics".

BRITISH INSTITUTION OF RADIO ENGINEERS, SCOTTISH SECTION (at the Scottish Lyceum Gallery, 11 Atholl Crescent, Edinburgh), at 7 p.m.—Messrs. E. G. Hamer and W. P. Cole: "Multi-Station V.H.F. Communication Systems using Frequency Modulation".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

BRITISH GLACIOLOGICAL SOCIETY (in the Department of Geography, Downing Place, Cambridge), at 8.15 p.m.—Mr. W. R. B. Battle: "Glaciological Investigations in North-East Greenland and Norway in 1948, 1949 and 1950".

Friday, February 2

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.15 p.m.—Dr. T. S. Work: "Cell Metabolism and Chemotherapeutic Activity".* (Further Lecture on February 9.)

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. H. G. Conway: "Industrial Design and its relation to Machine Design".

ROYAL SOCIETY OF MEDICINE, ANÆSTHETICS SECTION (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Dr. H. O. J. Collier: "Problems of Developing Muscle-relaxant Drugs in the Laboratory".

BRITISH PSYCHOLOGICAL SOCIETY, SOCIAL PSYCHOLOGY SECTION (in the Psychology Department, University College, Gower Street, London, W.C.1), at 8 p.m.—Mr. Eric L. Trist: "Some Social and Psychological Consequences of the Longwall Method of Coal-getting".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "High Vacuum".

Saturday, February 3

BRITISH INTERPLANETARY SOCIETY (in the Tudor Room, Caxton Hall, Westminster, London, S.W.1), at 6 p.m.—Dr. J. G. Porter: "Interplanetary Orbits".

BRITISH TRUST FOR ORNITHOLOGY in co-operation with the YORKSHIRE NATURALISTS UNION COMMITTEE FOR ORNITHOLOGY (in the Museum of the Yorkshire Philosophical Society, York), at 2.45 p.m.—Mr. W. B. Alexander: "Changes in the Distribution of British Birds".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT PHYSICIST IN THE RADIOTHERAPY DEPARTMENT—The Clerk to the Governors, St. Thomas's Hospital, London, S.E.1 (February 3).

GRADUATE (male) AS DEPUTY DIRECTOR OF EDUCATION—The Director of Education, International Wool Secretariat, Dorland House, 18–20 Regent Street, London, S.W.1 (February 3).

HEAD OF DEPARTMENT OF CHEMISTRY AND BIOLOGY, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham—The Chief Education Officer, County Offices, Chelmsford (February 3).

RESEARCH OFFICER to assist in aircraft stability investigations and in the measurement of stability characteristics in wind tunnel tests on radio-controlled models in free flight, and a RESEARCH OFFICER to assist with experimental and theoretical aerodynamic research on boundary layer control, at the Aeronautical Research Laboratories, Fishermen's Bend, Victoria—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1 (February 5).

ASSISTANT PHYSICIST (with an honours degree in physics and suitable post-graduate experience, preferably in hospital physics) at the Lincolnshire Radiotherapy Centre—The Secretary, Scunthorpe Hospital Management Committee, War Memorial Hospital, Scunthorpe, Lincs (February 7).

SCIENTIST, Grade I (with a good honours science or engineering degree and operational or other research experience)—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/285 (February 9).

RESEARCH FELLOWSHIPS and SENIOR FELLOWSHIPS in the Research School of Physical Sciences—The Administrative Officer of the Australian National University in the United Kingdom, 27 Russell Square, London, W.C.1 (February 10).

SENIOR LECTURER or LECTURER IN PHYSICAL METALLURGY, and a RESEARCH FELLOW IN METALLURGY—The Registrar, The University, Sheffield (February 10).

CHIEF ELECTRICAL ENGINEER (Mining) under the Chief Mechanical and Electrical Engineer in the Production Department at London headquarters—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/287 (February 12).

SENIOR LECTURER (with an honours or higher degree and have specialized in telecommunications or electronics) IN ELECTRICAL ENGINEERING—The Director, Robert Gordon's Technical College, Aberdeen (February 13).

LECTURER-IN-CHARGE OF PRODUCTION ENGINEERING, Department of Technical Education, New South Wales—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (February 14).

ASSISTANT ENGINEERS (Civil) to take charge of road construction and other engineering works in forests, and ASSISTANT ENGINEERS (Mechanical) for the organization, care and maintenance of mechanical equipment and vehicles—The Secretary, Forestry Commission, 25 Savile Row, London, W.1 (February 15).

CURATOR IN ZOOLOGY AND BOTANY—The Director, City Museum, Bristol 8 (February 15).

CHEMISTS in the Ministry of Supply (Chemical Inspectorate) for analysis of materials associated with atomic energy production, including radioactive materials, and development and application of up-to-date physiochemical techniques and equipments, in Cumberland and Lancashire—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.486/50A (February 17).

LECTURER IN ZOOLOGY at the University of Malaya—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (February 17).

SENIOR (1) and ASSISTANT RESEARCH APPOINTMENTS (2) IN ANTHROPOLOGY at the West African Institute of Social and Economic Research, University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (February 17).

LECTURER IN THE DEPARTMENT OF ZOOLOGY, Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (February 19).

MUSEUM ASSISTANTS in the Science Museum—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3446 (February 22).

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER for radiochemical research (Ref. F.790/50A), a SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (metallurgist or physical chemist) for research on the corrosion and protection of metals (Ref. F.791/50A), and a SENIOR SCIENTIFIC OFFICER and SCIENTIFIC OFFICER (physicists and mathematicians) for experimental and theoretical research in connexion with the design, construction and operation of atomic energy reactors (Ref. A.369/50A), at the Atomic Energy Research Establishment, Harwell—The Ministry of Labour and National Service, Technical and Scientific Register, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (February 24).

LECTURER IN APPLIED MATHEMATICS—The Secretary and Registrar, University College, Southampton (February 28).

LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING, University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (February 28).

PRINCIPAL OF THE NATIONAL COLLEGE OF FOOD TECHNOLOGY—The Secretary (F.E. Branch, Division 11Ia), Ministry of Education, Curzon Street, London, W.1 (February 28).

SENIOR LECTURER IN APPLIED MATHEMATICS—The Secretary and Registrar, University College, Southampton (February 28).

CHAIR OF BOTANY—The Secretary, University College, Southampton (March 3).

LECTURER OR ASSISTANT LECTURER IN CHEMISTRY—The Secretary, University College, Southampton (March 10).

CHAIR OF CHEMISTRY at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 12).

LECTURER IN PHARMACOLOGY AND THERAPEUTICS at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (March 15).

READER IN PHILOSOPHY, and a READER IN GEOGRAPHY, at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (March 15).

PROFESSIONAL ENGINEERS in many departments of the Civil Service for a wide variety of engineering duties—The Secretary, Civil Service Commission, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3225 (March 31).

SENIOR LECTURER IN EXPERIMENTAL PHARMACOLOGY—The Secretary of University Court, The University, Glasgow (March 31).

I.C.I. RESEARCH FELLOWSHIPS IN BACTERIOLOGY, BIOCHEMISTRY, BIOMOLECULAR STRUCTURE, BOTANY (plant biochemistry), CHEMICAL ENGINEERING, CHEMISTRY, CHEMISTRY OF LEATHER MANUFACTURE, CHEMOTHERAPY, COLOUR CHEMISTRY AND DYEING, ENGINEERING (civil, electrical or mechanical), FUEL AND REFRACTORIES, GEOLOGY (including geochemistry), METALLURGY, MINING (elective flotation and geophysical surveying), PHARMACOLOGY, PHYSICS, PHYSIOLOGY, TEXTILE INDUSTRIES (protein chemistry)—The Registrar, The University, Leeds 2 (April 30).

I.C.I. RESEARCH FELLOWSHIPS IN BIOCHEMISTRY, CHEMISTRY, ENGINEERING, PHARMACOLOGY, PHYSICS OR ALLIED SUBJECTS—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

I.C.I. RESEARCH FELLOWSHIPS IN CHEMISTRY, PHYSICS AND ALLIED SUBJECTS—The Registrar, The University, Manchester 13 (April 30).

I.C.I. RESEARCH FELLOWSHIPS IN PHYSICS, CHEMISTRY, BIOCHEMISTRY, ENGINEERING, METALLURGY, PHARMACOLOGY, CHEMOTHERAPY OR RELATED SUBJECTS—The Secretary of the Board of Research Studies, The Old Schools, Cambridge (April 30).

TUBE INVESTMENTS RESEARCH FELLOWSHIP tenable in the Department of Engineering Production—The Secretary, The University, Birmingham 3 (April 30).

TURNER AND NEWALL RESEARCH FELLOWSHIPS FOR RESEARCH IN ENGINEERING, INORGANIC CHEMISTRY, PHYSICS AND ALLIED SUBJECTS—The Registrar, The University, Manchester 13 (April 30).

ROYAL DUTCH SHELL STUDENTSHIP IN GEOPHYSICS—The Registrar, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7 (June 2).

EXPERIMENTAL and ASSISTANT EXPERIMENTAL OFFICERS at the Ministry of Supply Springfields Factory, Salwick, near Preston, to carry out experimental work arising from the metallurgical development involved in the production of atomic energy—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

GRADUATE ASSISTANT IN THE BIOCHEMICAL DEPARTMENT—The Secretary, Hospital Management Committee, Dudley Road Hospital, Birmingham 18.

HONOURS GRADUATES IN PHYSICS OR CHEMISTRY, to carry out research in the pottery industry—The Director, British Ceramic Research Association, Queens Road, Penkhull, Stoke-on-Trent.

METALLURGIST to take charge of a laboratory engaged on investigations essential to the development of metallurgical processes used in atomic energy production, a PHYSICAL CHEMIST to take charge of a laboratory engaged on corrosion investigations and the application of electro-chemical methods, and a MECHANICAL ENGINEER to take charge of a mechanical test laboratory, drawing office and machine shop—The Ministry of Supply, Division of Atomic Energy (Production), Risley, near Warrington, Lancs.

PHYSICISTS and MATHEMATICIANS (Experimental Officer grade) in Ministry of Supply research and development establishments mainly in the south of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.330/50A.

RESEARCH ASSISTANT for work in connexion with the use of radar in the investigation of clouds—The Secretary, Department of Physics, Cavendish Laboratory, Free School Lane, Cambridge.

SENIOR INVESTIGATOR (graduate) to undertake research in the Tinplate Section—The Director, Tin Research Institute, Fraser Road, Greenford, Middlesex.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Brompton Hospital Reports: a Collection of Papers recently published from the Hospital. Vol. 18, 1949. Pp. vii+221. (London: Brompton Hospital, 1950.) 12s. 6d. net. [1010

International Council of Scientific Unions: International Astronomical Union. Transactions of the International Astronomical Union. Vol. 7: Seventh General Assembly held at Zürich, August 11 to August 18, 1948. Edited by J. H. Oort. Pp. viii+552. (Cambridge: At the University Press, 1950.) 42s. net. [510

University of Bristol. Annual Report of the Agricultural and Horticultural Research Station (the National Fruit and Cider Institute), Long Ashton, Bristol, 1949. Pp. 174+8 plates. (Bristol: The University, 1950.) 12s. [1010

British Trust for Ornithology. Field Guide No. 2: How to Choose and Use Field-Glasses. By E. M. Nicholson. Pp. 8. (Oxford: British Trust for Ornithology, 1950.) 9d. [1010

Photographic Aspects of the Radiography of Welded High Pressure Vessels. By Dr. L. Mullins. Pp. 28. (London: British Welding Research Association, 1950.) 2s. [1010

B.I.O.S. Surveys. Report No. 31: Packaging in Germany during the Period 1939–1945. Prepared by Miss A. E. Wiegand. Pp. 61+13 plates. (London: H.M. Stationery Office, 1950.) 2s. net. [1010

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 620, Vol. 234: The Comparative Investigation of Apices of Vascular Plants by Experimental Methods. By C. W. Wardlaw. Pp. 583–604+plates 33–35. (London: Cambridge University Press, 1950.) 9s. [1010

British Internal Combustion Engine Research Association. Seventh Annual Report, 1st April 1949–31st March 1950. Pp. 20. (Slough: British Internal Combustion Engine Research Association, 1950.) [1210

Recommendations for the Metal Arc Welding of Butt Welds in Steel Pipelines for Power Plant. Pp. 20. (London: British Welding Research Association, 1950.) 2s. [1210

General Register Office. The Registrar General's Quarterly Return for England and Wales: Births, Deaths and Marriages, Infectious Diseases, Weather, Survey of Sickness, Population Estimates, Quarter ended 30th June 1950. Pp. 32. (London: H.M. Stationery Office, 1950.) 1s. net. [1210

Film Centre Educational Pamphlets. 1: The Film and Fundamental Education. By H. G. A. Hughes and Sinclair Road. Pp. iv+20. 1s. 2: Film and Filmstrip Projection in Fundamental Education. By Peter Brinson. Pp. ii+22. 1s. 3: Choice and Care of Films in Fundamental Education. By Peter Brinson. Pp. ii+22. 1s. 4: Choice and Care of Filmstrips in Fundamental Education. By George Seager. Pp. iv+20. 1s. (London: Olen Press, 1950.) [1210

Other Countries

Papers of the Michigan Academy of Science, Arts and Letters. Vol. 32 (1946.) Pp. xiv+522. 60s. net. Vol. 33 (1947.) Pp. x+414. 60s. net. (Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press, 1949–1950.) [1010

Reports of the Biochemical Research Foundation of the Franklin Institute. Vol. 10, 1948–1949. 18 papers. (Newark, Del.: Biochemical Research Foundation, 1950.) [1010

New Zealand Department of Science and Industrial Research: Apia Observatory. Annual Report for 1942. Pp. iv+166. 5s. Annual Report for 1947. Pp. ii+157. 6s. (Wellington: Government Printer, 1950.) [1010

Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture. Comptes rendus des recherches, No. 4: Travaux du Comité pour l'Etablissement de la Carte des Sols et de la Végétation de la Belgique. Pp. 278. (Bruxelles: Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture, 1950.) 125 francs. [1010

Tidal Forces in the Sun's Corona due to Planets. By K. G. Meldahl. Part 2. Chart 147½ in. × 24½ in. (Copenhagen: Berlingske Forlag, 1950.) [1210

Commonwealth Scientific and Industrial Research Organization. Bulletin No. 242: Age, Rate of Growth, and General Life-History of the Australian Pilchard (*Sardinops neopilchardus*) in New South Wales Waters. By M. Blackburn. Pp. 86+8 plates. Bulletin No. 251: Measures of Abundance of certain Pelagic Fish in some South-Eastern Australian Waters. By M. Blackburn and J. A. Tubb. Pp. 74+2 plates. Bulletin No. 252: The Influence of Diet on Dental Development in the Sheep. By M. C. Franklin. Pp. 34+23 plates. (Melbourne: Government Printer, 1949–1950.) [1210

American Institute of Crop Ecology. International Agro-Climatological Series, Study No. 13: Agricultural Climatology of Siberia, Natural Belts and Agro-Climatic Analogues in North America. By M. Y. Nuttonson. Pp. 64. (Washington, D.C.: American Institute of Crop Ecology, 1950.) [1210

Records of the Geological Survey of India. Vol. 82, Part 1: General Report of the Geological Survey of India for the Year 1948. By Dr. W. D. West. Pp. 253. (Calcutta: Geological Survey of India, 1950.) 6.6 rupees; 10s. [1210

Factors Regulating Blood Pressure. Transactions of the Third Conference, May 5–6, 1949, New York. Edited by B. W. Zweifach and Ephraim Shorr. Pp. 280. (New York: Josiah Macy Jr. Foundation, 1950.) 2.55 dollars. [1210

Problems of Infancy and Childhood. Transactions of the Third Conference, March 7–8, 1949, New York. Edited by Dr. Milton J. E. Senn. Pp. 156. (New York: Josiah Macy Jr. Foundation, 1950.) 1.25 dollars. [1210

Bulletin of the Geological Society of America. Vol. 61: Studies of Heavy Detrital Minerals. By C. Osborne Hutton. Pp. 635–710+4 plates. (New York: Geological Society of America, 1950.) [1210

India Meteorological Department. Scientific Notes, Vol. 11, No. 135: Discussion on a Method of Predicting Night Minimum Temperature in Winter. By K. C. Chakravorty. Pp. 39–46. (Delhi: Manager of Publications, 1950.) 1.2 rupees; 1s. 9d. [1210

Zoology Publications from Victoria University College. No. 1: Studies on New Zealand *Hirudinea*. Part 2, *Branchellion parkeri*, a New Ichthyobdellid Leech. By L. E. Richardson. Pp. 12. No. 2: Four New Species of Fresh-water Ciliates from New Zealand. By Brian M. Bary. Pp. 20. No. 3: New Zealand Coelenterates: Ctenophores from Cook Strait. By Patricia M. Ralph and C. Kaberry. Pp. 12. No. 4: The Kirk Collection of Sponges (Porifera) in the Zoology Museum, Victoria University College. By H. Barracough Fell. Pp. 12. No. 5: Some Blood Parasites of New Zealand Birds. By Marshall Laird. Pp. 20. No. 6: A New Genus and Two New Species of Peloridiidæ (Homoptera) from New Zealand. By Carl J. Drake and J. T. Salmon. Pp. 8. (Wellington: Victoria University College, 1949–1950.) [1210

UNIVERSITY OF BIRMINGHAM

DEPARTMENT OF ENGINEERING PRODUCTION

TUBE INVESTMENTS RESEARCH FELLOWSHIP

Applications are invited for the Tube Investments Research Fellowship tenable in the Department of Engineering Production. The appointment will date from October 1, 1951, or a suitable date thereafter. Candidates should give details of their career and of their academic qualifications, and must also state the particular lines of research which they are desirous of pursuing within the field of engineering production and industrial management. The Fellowship is normally awarded for two to three years, subject to review each year, and carries a salary of £1,000 to £1,500 per annum, according to qualifications.

Further particulars may be obtained from the undersigned, to whom applications must be submitted in triplicate not later than April 30, 1951.

C. G. BURTON,
Secretary.

The University,
Birmingham, 3.

UNIVERSITY OF LEEDS

Applications are invited for Imperial Chemical Industries, Limited, Research Fellowships in bacteriology, biochemistry, biomolecular structure, botany (plant biochemistry), chemical engineering, chemistry, chemistry of leather manufacture, chemotherapy, colour chemistry and dyeing, engineering (civil, electrical or mechanical), fuel and refractories, geology (including geochemistry), metallurgy, mining (selective flotation and geophysical surveying), pharmacology, physics, physiology, textile industries (protein chemistry). Fellowships will be of an annual value within the range £600 to £900 a year according to qualifications and experience and will normally be tenable for three years.

Further particulars can be obtained on request. Three copies of applications (one in the case of applicants from overseas), together with the names of two referees, should reach the Registrar, The University, Leeds, 2, not later than April 30, 1951.

POSTGRADUATE SCHOLARSHIPS IN TEXTILES

The British Rayon Research Association invites applications from university students who expect to graduate this year for scholarships in textile technology, textile engineering, textile chemistry, or dyeing. The scholarships are normally of the value of £300 a year, plus fees, but in special circumstances an increased allowance may be paid. Scholarships are tenable at Leeds, Manchester or other universities or technical colleges where there are appropriate facilities, for a period of two years, though this may be extended in suitable cases by a year of study overseas.

For further particulars and application forms write to the Secretary, British Rayon Research Association, Barton Dock Road, Urmston, near Manchester.

UNIVERSITY OF LONDON

The University will shortly proceed to award the Mary Scharlieb Research Studentship, of the value of £250, for one year in the first instance. The Studentship is open to graduates of the University who are registered medical practitioners or possess qualifications which in the opinion of the Senate would enable them to undertake postgraduate medical research.

Applications (on a prescribed form) must reach the Academic Registrar, University of London, Senate House, London, W.C.1 (from whom a form of application and further particulars may be obtained), not later than February 28, 1951.

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UNIVERSITY OF BIRMINGHAM

I.C.I. FELLOWSHIP

Applications are invited for an Imperial Chemical Industries, Ltd., Research Fellowship tenable in the university. Preference will be given to candidates in the fields of nuclear physics or radiochemistry. The appointment will be for a term of years and will carry superannuation benefits and family allowance on the university's scale. The basic stipend will depend upon the Fellow's experience and qualifications, and will lie within the range £600 to £900 per annum.

Applications, together with a list of scientific publications and the names of two referees, should reach the undersigned not later than April 1, 1951.

C. G. BURTON,
Secretary.

The University,
Birmingham, 3.

UNIVERSITY OF MANCHESTER

TURNER AND NEWALL RESEARCH FELLOWSHIP

Applications are invited for the above research fellowship, normally of the value of £600 per annum, founded by Turner and Newall, Ltd., tenable in the university and available for research in engineering, inorganic chemistry, physics, and allied subjects.

Regulations governing the award of the Fellowship may be obtained from the Registrar, the University, Manchester, 13, to whom all applications should be sent not later than April 30, 1951.

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